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CONTENTS.

Editorial 379
Ohio Electric Light Convention 382
Prescott, Ariz., Hydro-Electric Plant 382
Kuzel Tungsten Filament Patent 382
Effect of Wave Form Upon Iron Losses in Transformers 383
Electricity in German Agriculture 383
Swedish Electric Traction 384
Destruction of Wooden Electrical Poles 385
The Atlantic Cable of 1858. By William Maver, Jr. 385
Current News and Notes 387
Interconnected Hydro-Electric Generating Station 389
Synchronous Motor in Systems Operating at Low Power Factor—I. By F. C. Helms 391
Electrical Improvements at Elmira, N. Y. 395
Improvements on Unipolar Generators 397
Resistance of Lightning-Arrester Earth Connections. By E. E. F. Creighton 397
A. I. E. E. Papers on Electric Railways 400
Southern Power Company's System 400
Test of Gas-Electric Generating Station 400
A. I. E. E. Papers on Telephone and Telegraph Systems 401
Electricity and Fire Protection 401
Electric Heating 401
Day Load for Electric Light Stations. By James Francis 401
Handling of Complaints. By S. H. Williams 402
Pertinent Considerations of Power House Locations. By E. D. Dreyfus 403
British Conduit for Interior Open Wiring 405
Adapted Transformer for Single Lighting Units in House Illumination 405
Improvements in Luminous Arc Lamps 406
LETTERS TO THE EDITORS:
Symbols for Physical Quantities. By B. A. Behrend and M. V. Ayres 407
Motor-Control. By Harold M. Martin 408
Limitation in Engineering Specifications. By Harry O. Allen 408
Testing Underground Cables. By Max Freimark 408
Tabulation of Engineering Data. By H. S. Pardee 408
Digest of Current Electrical Literature 409
New Apparatus and Appliances 413
Industrial and Commercial News 417
General News 421
Weekly Record of Electrical Patents 427

HIGH BUILDINGS AND WIRELESS TELEGRAPHY.

A semi-permanent wireless telegraph station has been maintained for more than a year by the French government at the Eiffel Tower in Paris, and it is stated that spark-messages sent with a 10-kw installation have been read at Morocco in the south, and Nova Scotia in the west. Although advantageous for wireless telegraphy by reason of its height, the Eiffel Tower is not ideally situated in this respect. The ideal requirement is a tall structure of non-conducting or electrically disintegrated conducting material, supporting an aerial framework of considerable effective area, rising from a good electrically conducting sheet, for wave reflecting purposes, connected to good ocean ground to ship off the waves in all directions without loss after they have been generated. Mere height above sea level, such as is provided on a high mountain summit, appears to be of no benefit; since it is the height above the conducting ground base, or electric mirror, that counts.

It is announced that according to the plans for the reconstruction of the Mills Building on Broad Street, New York City, that structure is to be carried to a height of 1000 ft., or 305 m, above the base, so as to be by some 5 m the highest structure in the world. A wireless station at the base of this building, using the summit for the support of its aerial, should therefore be situated more favorably than the Eiffel Tower station in regard to proximity to the ocean, although less favorably than the Eiffel Tower in regard to the presence of surrounding tall conductors, such as the Singer and Metropolitan Life towers, or the Brooklyn Bridge. It seems to have become necessary to bury the wireless plant at the foot of the Eiffel Tower in an underground vault, in order to preserve æsthetic appearances and to keep down the noise of the sparks in sending. The time will probably come when transmission by sparks from a large land station will be looked upon as clumsy and ineffective, by comparison with the more modern sparkless methods of sustained oscillations, which have not yet had time to come into extensive use; but almost any station, even if noiseless in operation, would be likely to mar the graceful symmetry of the Eiffel Tower, and there would doubtless be justification for going underground on the score of appearances alone.

SELECTIVE RADIATION FROM THE NERNST GLOWER.

A recent number of the *Bulletin* of the Bureau of Standards contains a paper by Mr. W. W. Coblentz, abstracted in the Digest, on an experimental study of the radiation emitted by a Nernst glower in different parts of the spectrum and also at different temperatures. The subject of power radiation from a heated body is of comparatively recent development. Although a large amount of work has already been done in this direction, and a very respectable amount of literature on the subject has been accumulated, but little progress has yet been made toward a complete understanding of the process. In the case of a glowing platinum filament lamp, the power ra-

diated is a maximum at a certain point in the spectrum which depends upon the temperature attained, and which shifts toward the violet as the temperature is increased. The rise to the maximum is very steep on the violet side, but is much more gradual on the red side. A formula has been found which fits the curve fairly well. There is no gap or discontinuity anywhere in the radiation curve. The great bulk of the power is radiated at the red end of the spectrum, as dark heat.

A Nernst glower appears to give a different kind of spectrum to that emitted by a metallic glower, in general, or a platinum glower in particular. It begins as a number of separate bands of color, which broaden out as the temperature rises, and finally merge into a continuous spectrum. The shape of the radiation curve thus formed, after the merger is complete, is noticeably different from that of the glowing metallic filament. The latter has but one hump or maximum. The Nernst glower curve has two humps, one toward the violet end, and the other toward the red end, of the spectrum, the positions of, and distances between, these humps varying with the temperature and also with the glower. It seems evident that the temperature of a glowing Nernst-filament does not admit of being measured from its radiant energy according to the same law that has been thus far found to apply to a metallic filament. Moreover, much more experimental research will probably have to be made, and much more generalization reached, before the seemingly paradoxical behavior of the radiant distribution in electrolytically conducting glowers of the Nernst type can be accounted for.

The Synchronous Condenser.

Probably of all of the characteristic performances of the synchronous motor, none is more interesting than its operation as a "condenser"; that is, its tendency to draw leading wattless current from the supply system when its field current is increased above that value giving minimum armature current. Although the machine possesses this tendency to a marked extent, it exhibits few of the characteristics of the apparatus known as a stationary condenser. For example, when the machine is operating as a synchronous condenser, an increase in the supply e.m.f. results in a decrease in the leading wattless current in its armature, while a stationary condenser takes a leading wattless current which continues to increase in value as the supply e.m.f. is increased. The condenser action of a synchronous motor can conveniently be investigated by neglecting momentarily certain minor modifying influences. With a degree of accuracy amply satisfactory for practical purposes, it may be said that throughout its working range the wattless component of current in the armature of a synchronous motor varies directly with the change in the field current from that value which causes the counter e.m.f. of the armature to equal the e.m.f. impressed upon the armature leads. This action is attributable to the demand for a counter e.m.f. equal to the impressed and therefore for a relatively constant field magnetism independent of the value of the field current. The excess or deficiency in magnetomotive force supplied by the field circuit ampere-turns above or below that necessary to maintain the required field magnetism is supplied by a wattless leading or lagging component of the armature current. The latter component may be considered as a "condenser" current having either a positive or a negative value according to whether the field current is above or below that value which causes the condenser current to reduce to zero.

The advantages attending the use of a synchronous condenser for improving the power factor of a transmission system are discussed by Mr. F. C. Helms in an article appearing on page 391 of this issue. It is worthy of note that the exact amount of change in power factor is not always a true measure of the advantage of eliminating wattless currents from a transmission system. For example, it might seem that a change that would result in increasing the power factor from 78 per cent to 95 per cent is far preferable to a change that would increase the power factor from 95 per cent to 100 per cent. However, the former change indicates the neutralization of the same value of wattless current as does the latter change, and in many cases the detrimental effect of operating a low power factor varies directly with the value of the wattless currents present in the system rather than with the difference between the actual power factor and 100 per cent.

The Luminous Overshooting of Tungsten Incandescent Lamps.

In our issue of April 25, Mr. J. B. Taylor drew attention to a remarkable phenomenon of momentary excessive brightness in the filament of a tungsten incandescent lamp, when first turned on after having been out of service for a considerable period, and he named the phenomenon *overshooting*. In a subsequent issue (May 16) Mr. Taylor corroborated his first announcement by photographic observations. We recommended at the time that further observations should be made with an oscillograph, in order to analyze the electrical actions and assist in detecting the cause of the luminous overshooting. In our issue of last week Mr. J. Stuart Freeman contributes an article on some further experimental evidence, using the oscillograph, and confirms Mr. Taylor's original observations in all 16-cp tungsten lamp consuming 15 watts started off with 8.4 reached incandescent temperature in one-sixtieth of a second, so that its initial rate of increase of temperature must have been roughly 80,000 deg. C. per second. The excess of current in the lamp lasted only two-tenths of a second, and half of the excess was over in a much shorter time—about one-hundredth of a second. This overshooting of current is, however, only what might be expected, and was well known to exist in any metallic-filament lamp. The remarkable fact is that a distinct overshooting in candle-power occurs during the first fifth of a second, and particularly during the first tenth.

There are two theories that naturally suggest themselves. One is that a cold tungsten-filament absorbs and occludes certain gaseous substances from the low-pressure space within the chamber; that by virtue of the presence of these gases the filament shines more brightly when first brought suddenly to incandescence, but that after the gases have been driven off by heat, the extra luminescence is lost, and can only be regained after prolonged cooling and rest. The other theory is that the increase of resistance accompanying rise of temperature takes a certain small interval of time to be established, so that when the temperature is rising at the rate of tens of thousands of degrees per second, the resistance lags appreciably. The resistance does not shut off the current as promptly as it should and an extra rush of current and heat energy gets through the filament, bringing the temperature higher than normal, with a corresponding increase in brilliancy. The first theory is purely chemical, or at least physico-chemical. The second theory is purely electrical, or at least electro-thermal. According to Mr.

Freeman's article, the oscillographic overshoot of current was the same whether the current was turned on to a cold filament with luminous overshooting, or whether it was turned on to a more recently excited filament with no luminous overshooting. That is, the current jumped up to 5.7 amp, or 8.4 fold, whether there was luminous overshooting or not. The oscillographs accompanying the article do not enable this statement to be checked, because in the first tungsten oscillograph, the ordinate at *B* is about eight times the ordinate at *D*, whereas in the second tungsten oscillograph, the ordinate at *B* only appears to be a little over four times the ordinate at *D*. However, prints from oscillographs are often misleading in appearances. If Mr. Freeman's statement is correct, that the current overshooting in both cases is the same, then the electrical theory must be excluded and some chemical theory is indicated.

One other experiment might be tried before handing the investigation over to the students of vacuum-tube phenomena. That is, to take similar oscillographic records with inductance in the circuit of the lamp, so as to cut down the abruptness of the first current rush, thus delaying the appearance of incandescence, say, to one-twentieth of a second from the circuit closing. If the luminous overshooting depends upon rate of increase of temperature, it should be then much lessened. If it only depends upon the attainment of incandescent temperature after prolonged rest, the inductance should make but little difference. The cyclic lag of luminescence behind current in a tungsten lamp supplied by alternating-current mains is very interestingly brought out in Mr. Freeman's Fig. 4, although this is much less wonderful than the main phenomenon of luminous overshooting. If the luminous overshooting does not involve extra current rush as the article intimates, it follows that the tungsten-filament gives more light for a given amount of energy when it starts off cold than after it has had time to get thoroughly heated up. It requires to be explained how this increase in luminous efficiency is produced.

IRON LOSSES IN TRANSFORMERS.

It is now about 10 years since the question of the best wave form of alternating e.m.f. for supplying transformers assumed so much importance as a topic of technical discussion. The facts are now universally admitted that if transformers are to be operated at constant potential, there is a distinct reduction in their core loss when they are supplied with a peaked wave of voltage, and a corresponding distinct increase in their core loss when they are supplied with a flat wave of voltage. The transformer copper losses remain the same under these different conditions, as likewise the eddy-current loss in the core. The difference in core losses is attributable to the difference in hysteretically wasted power due to the different maximum flux density produced cyclically in the iron, a peaked form of wave giving rise to a lower maximum cyclic density of magnetism than a flat form of wave. Very large transformers waste only about 1¼ per cent of the power they receive at full load, and only about two-thirds of this, or say ⅞ per cent, in hysteresis; so that if large transformers were worked under rated load continuously, the reduction of their hysteretic waste would not assume serious economic proportions. In a suburban distribution system, however, where many transformers are small, with larger percentages of wasted power, and where the transformers are working under rated load for only about an hour daily, the annual hysteretic consumption of energy in transformers may readily exceed 5 per cent of the total output of the station, while in particular cases it may be 10 per cent or more. Under such conditions, plans for diminishing hysteretic loss by altering the shape of the generator wave are worthy of discussion.

The trend of modern practice in the construction of alternators has, however, not been toward high-peaked waves of voltage, but toward simple sinusoidal waves. There are several reasons for this tendency. In the first place, alternators tend to run together in parallel with least idle current, and with maximum stability, when their e.m.f. waves are simple sinusoids. The same condition applies to the best operation of synchronous motors, which may be looked upon virtually as alternators, in parallel busbar connection, devoid of steam supply. In the next place, peaked waves, while diminishing the hysteretic waste in induction motors, do not produce such good motive conditions in induction motors as sine waves. Thirdly, peaked waves of e.m.f. are apt to generate unduly powerful charging currents in underground cable feeders, and also unduly powerful charging currents in long aerial transmission lines. The advantages then of peaked e.m.f. waves in diminished cyclic magnetic flux and diminished hysteretic loss, are outweighed at present by the above disadvantages. A recent paper by Mr. Morton G. Lloyd, in the *Bulletin* of the Bureau of Standards, discusses the results of an experimental research into the effect of e.m.f. wave form on transformer core losses. It appears that with the best kind of a peaked wave used in the experiment, the core losses in certain small transformers were reduced 8.3 per cent, whereas with the flattest type of wave that was experimented with the core losses were increased 6 per cent. In these transformers the hysteretic loss was from 60 per cent to 75 per cent of the total core loss. If, therefore, under laboratory conditions, the reduction in core loss by a chosen wave form was only 8 per cent as compared with a sine wave, it is fairly safe to assume that under practical conditions the saving in power supplied to transformers working on light load would not exceed 5 per cent, so that it would not be worth while using a kinky peaked wave of alternator e.m.f. for so small a reduction.

The paper proposes that the criterion of a peaked or flat wave shall be determined by the form-factor of e.m.f. or ratio of voltmeter reading to arithmetic mean voltage in a half cycle. All form factors which exceed that of a sine wave are to correspond to and determine peaked waves, while all form factors less than that of a sine wave are similarly to denote a flat wave. It is very properly pointed out that if this definition, or an equivalent, be not adopted, we are unable to say that in all cases a peaked e.m.f. wave reduces the flux and the hysteretic loss. It is sometimes very difficult to say when a wave ceases to be flat, and becomes peaked, by sole recourse to the graphic analysis of the unaided eye. A distinct deviation is noticeable between some of the experimental results and those predicted theoretically. The paper points out that such discrepancies are readily introduced by the influence of resistance in the circuits under test, and its disturbing effect on wave form. Moreover, the law of hysteretic waste of power was taken according to the Steinmetz formula at the 1.6th power of the cyclic flux density. It is known, however, that this is only a first approximation sufficiently good for practical purposes, and that the exponent not only varies slightly in different samples of iron, but also varies slightly with the flux density in one and the same sample. Consequently, discrepancies might be expected from this cause alone.

Ohio Electric Light Convention.

Responses to inquiries by the secretary of the Ohio Electric Light Association indicate that the attendance will be large at the coming convention at Put-in-Bay Island, to be held Aug. 25, 26 and 27. The following questions, which will come before the meeting, have been submitted to the membership with a request that replies, including any experience bearing on the several matters, be contributed:

What percentage of gross receipts can be profitably spent in obtaining new business, and how much of this percentage should be devoted to advertising?

What connected load in 16-cp lamp equivalents per capita of population can be reasonably expected in central-station service?

What instructions are necessary to give linemen regarding the hazard from live wires?

What is the percentage of loss usually incurred between switchboard and consumer?

Experience with high-tension wires and how best to afford protection from danger.

Joint construction work with other public service companies, and best methods and means to control the same.

Papers will be presented dealing with the following topics: Gas engines, gas-producer plants and oil-engine plants; methods of increasing business and of eliminating private plants and meeting gas competition in central-station territory; erecting signs and wiring houses as central station undertakings; illuminating engineering; municipal lighting stations; grounding secondary circuits, and experience with high-efficiency lamps.

The completed program of the convention was published on page 172 of our issue for July 25, 1908. Abstracts of the papers will appear in subsequent issues.

Prescott (Ariz.) Hydro-Electric Plant.

The Arizona Power Company will soon have completed the first section of a 6000-hp hydro-electric development at Prescott, Ariz. The enterprise was financed in the fall of 1907 through the efforts of Messrs. William P. Bonbright & Company, of New York City, and A. C. Balch, Los Angeles, Cal., and the Electric Operating Construction Company, 49 Wall Street, New York. The plant is located 50 miles east of Prescott, the water being derived from Fossil Creek Springs, which furnish an unvarying supply regardless of rainfall. During the 40 years that the Springs have been known the flow has been practically uniform.

The enterprise is designed to produce ultimately about 6000 electrical horse-power in two developments. The first, which is now being constructed, is capable of producing 4000 hp, which will be transmitted to a distributing substation near Huron, Ariz., on the line of the Santa Fe, Prescott & Eastern Railroad, branching at that point to Prescott, Jerome and reaching the large mines in the adjacent district. The current will be transmitted at 45,000 volts, the transmission line consisting of steel towers 40 ft. in height, carrying two separate and distinct circuits supported by double swinging insulators. The distance between towers is 500 ft., and the entire line is to be protected by a grounded steel cable firmly fastened to the top of each tower by a special clamping device.

The head obtained at the first and larger development is approximately 1100 ft., and the first power house, located on the Verde River, will be equipped with three 1800-kw generators and necessary transformers and switching devices. The water conduit for this development is about six miles in length, including 10,000 ft. of tunnels, the longest being 2600 ft. A siphon pipe 7500 ft. long and 45 in. in diameter is used in the middle of the conduit to carry the water across extremely rugged and precipitous gorges, where the construction of flumes on trestles would be very expensive. The penstock is 4900 ft. in length.

All of the construction, which is being carried on under the direction of Mr. R. S. Masson, the chief engineer for the Electric Operating Construction Company, managers for the Power company, is of the most substantial character, all buildings being of reinforced concrete with iron or tile roofing. The work is rendered particularly difficult by reason of the unsettled character of the country and the distance from railroad transportation. A wagon road 40 miles in length has just been completed from the railroad station at Blue Bell, Ariz., to the intake at Fossil Creek. The portion of this road which descends from the tablelands to the Verde River drops over 3000 ft. in the length of 7 miles, and a large portion of the distance is built on the face of the cliffs with a grade of 10 to 15 per cent.

Orders for all of the apparatus have been placed and delivery will commence in the early part of September, it being confidently expected that power will be available for consumers in the early part of 1909. About 200 miles of No. 1 and 250 miles of No. 4 copper wire will be used.

Kuzel Tungsten Filament Patent.

A patent issued Aug. 11 to Hans Kuzel, Vienna, Austria, relates to a process whereby it is practicable to obtain much thinner tungsten filaments than by previous processes. The claims are, first, for obtaining particularly thin filaments by a process consisting in producing a plastic mass containing tungsten and colloidal oxynitrid of tungsten, drying the filaments obtained therefrom and finally gradually heating them to a white heat in a non-oxidizing temperature; and, second, on a thread capable of being converted into a crystalline tungsten filament and containing tungsten and colloidal oxynitrid of tungsten.

In the specification it is stated that according to H. Schulze (*Journal für Praktische Chemie*, XXXII, page 399) colloidal tungsten is obtained by reducing tungstic trioxide with potassium cyanide. But from a paper of Dèsi (*Journal of the American Chemical Society*, 1897, page 239) it is seen that the reaction goes on differently according to the temperature maintained. On the one hand at the most intense white heat the reaction leads to crystalline or molten tungsten, while on the other hand when working at as low a red heat as possible, an oxynitrid in the form of black powder is obtained, the exact composition of which could not be found. By heating tungstic trioxide with sal ammonia, Dèsi obtained the same oxynitrides (l. c. page 236) which likewise could not be defined exactly. According to the temperature at which the reaction was carried out the black bodies obtained showed, when analyzed, a varying percentage of tungsten, down to 83 per cent and even less.

The varying results of the analysis might possibly be explained by assuming that when working at low temperatures besides an oxynitrid of a well defined composition, there is produced simultaneously therewith always a larger or smaller amount of colloidal tungsten. The inventor states that he has found that these black substances containing oxynitrids of tungsten are partly already in the colloidal state, and that they may be readily converted completely into the colloidal state by the method of his patent, 871,599, Nov. 19, 1907, which consists in treating the most finely comminuted substance alternately with solutions of an acid and a non-acid character under thorough agitation and also heating to a temperature not exceeding 100 deg. C.

The object of the present invention is to utilize these black more or less colloidal products containing oxynitrids for manufacturing filaments. The substance obtained as above described in a more or less completely colloidal state is worked into a plastic mass in the known manner either by removing therefrom any superfluous imbibition liquid by cautious evaporation or by pressure or by incorporating into the substance the required quantity of imbibition liquid by thorough mixing and agitation or kneading.

From the plastic mass thus obtained threads are made in any known manner, preferably by squirting these threads containing tungsten and colloidal oxynitrides of tungsten. They are then cautiously dried and finally gradually heated to a white

heat, preferably by an electric current passed through them. The heating is effected in a non-oxidizing atmosphere either in an inert or reducing gas, such as hydrogen or nitrogen, and preferably in the form of a current; or it may be *in vacuo*, the vacuum being maintained uniform during the heating as nearly as possible by means of an efficient pump. By such heating, the colloidal tungsten is converted into the crystalline state and at the same time the oxynitrides of tungsten are reduced to tungsten, also in the crystalline state, so that a filament consisting of pure tungsten in the crystalline state is obtained which is ready for use. This conversion is accompanied by a reduction of the diameter and the length of the filament, this reduction being nearly twice the shrinking of pure colloidal tungsten. By using the black colloids containing oxynitrides of tungsten it is therefore possible to obtain most easily much thinner filaments than by using pure colloidal tungsten. The great shrinkage is fairly well explained by the fact that the colloid containing oxynitrides contains only 83 per cent tungsten and that these colloidal threads, as has been shown by experiment, are capable of retaining more imbibition liquid (possibly in the form of gel water which plays a part similar to that of crystal water) than the colloidal tungsten.

The inventor states that the importance of the new process is clearly shown by the fact that a necessary condition for the production of high voltage and low candle-power lamps (110 volts and 16 cp or 110 volts and 10 cp) is to obtain most fine filaments, the diameter of which is about 0.015 to 0.02 mm.

Effect of Wave Form Upon the Iron Losses in Transformers.

Dr. Morton G. Lloyd, in a paper printed in the *Bulletin* of the Bureau of Standards, gives the results of an exhaustive investigation of the effect of wave-form upon iron losses in transformers.

The first part of the paper is highly mathematical and deals with the theoretical considerations involved. The case of one harmonic is first analyzed, then the case of two harmonics, and finally, the case of several harmonics. The following sections give descriptions of the apparatus employed, methods of testing, the experimental results, a discussion of the results and final conclusions.

The data of the tests show that in the simple case of a single harmonic of small magnitude, the experimental results agree with the theoretical values within 1 per cent. When, however, the higher harmonics enter in large proportion, agreement was not so good; for example, with 20 per cent of the ninth harmonic, the discrepancy exceeded 1 per cent.

Dr. Lloyd concludes that it is apparent that transformer losses may be gradually reduced by using an appropriate form of wave. When a generator is to be used primarily or principally to supply transformers whose load does not require a sine wave, it would be advantageous to design it with a wave form suitable for the accomplishment of this result. The desired result could be assured by the presence of a considerable component of the third harmonic in reversed phase, and suppressing as far as possible the higher harmonics, unless the phases of these can be controlled. This would give an unmistakably peaked wave.

If the generator be three-phase, three-wire, it is not desirable to introduce the third integral multiple of third harmonic. For, if star-connected, the harmonic does not appear in the line voltage; if delta-connected, a large short-circuit current of the triple frequency may circulate in the armature, wasting power. In this case it would be desirable to choose higher harmonics to produce the desired effect. These can be introduced by a suitable choice of armature teeth, not pushed to a too-high flux density. In introducing harmonics, however, it is always necessary to consider the danger from resonance.

If the generator is to be used on a high-tension line, the objection must be met that a peaked wave requires a higher maximum e.m.f. for the same effective voltage, and consequently better insulation is required. While this argument carries some weight, it is sometimes overrated. The energy lost by leakage is independent of wave form. As for the breakdown of the insulation, it has been shown that the steady voltage necessary for rupture may be greatly increased for a fraction of a cycle without breakdown. Furthermore, most breakdowns on high-voltage lines can be traced to surges of abnormal voltage due to some unusual condition, such as opening or closing a switch, not dependent upon the wave form, or to accidental resonance with some high harmonic. The insulation is liable at any time to be subjected to a stress due to twice the effective voltage. It cannot be taken for granted, consequently, that a peaked wave would require higher insulation than the same effective voltage in a sine wave. It would be advisable, however, to avoid high harmonics in the wave in order to lessen the danger from resonance effects.

A greater objection to a peaked wave on long transmission lines is the fact that the high maximum e.m.f. requires a larger charging current. How serious this feature of the case may be depends upon the constants of the particular line considered and the amount of power transmitted.

If the secondary has an inductive load, so that its current and the corresponding component of primary current are not in phase with the e.m.f., the difference in wave form due to the ohmic drop in potential will be accentuated, and the effect of the generator e.m.f. upon the iron losses will be less certain.

The final conclusions of the paper are as follows: With a given effective e.m.f. the iron losses in a transformer depend upon the form factor of the e.m.f. and vary inversely with it. With a given form of wave, the effect upon the iron losses may be computed approximately from the formulas derived, providing the higher harmonics are not prominent. By proper design of the generator supplying transformers, the iron losses may be reduced to a minimum.

Electricity in German Agriculture.

An address was delivered recently before the Prussian Agricultural Society on the use of electricity on the farm, by Mr. Von Podbielski, the former Minister of Agriculture. The discussion by him was of a general nature, but touched a number of points of interest. Attention was directed to the general and varied use to which the same motor could be put, and illustrations were shown of a portable motor running a mill for breaking oil cakes, and the same motor used in connection with a pump to drain water from swampy ground. Some of the larger farms use electric trolley cars to handle produce, and the electric railroad of the great Dahlwitz farm was instanced. Mr. Von Podbielski offered the following suggestions on the subject in reply to an inquiry from the United States Consul at Hanover, Mr. R. J. Thompson: "If even a very small profit is to be derived from agricultural work, the farmer is bound to use machinery instead of day labor, because the wages for the latter are steadily increasing. Electricity is the power wanted and is the best adapted to the work. Electricity is always at hand when the proper conductors are provided. Until very lately it could not be used extensively on account of the great price for the kilowatt-hour, charges of from 40 to 60 pfennigs ($0.0952 to $0.1428) for the kilowatt-hour excluding its use for agricultural purposes. According to my calculations the price for the kilowatt-hour in Germany, in order to leave a reasonable profit, should be no more than 20 pfennigs ($0.0476); and if installations, already in existence, of turbines are employed it is possible to furnish electricity at such a price. At our coal centers the kilowatt-hour is already furnished at from 6 to 7 pfennigs ($0.014 to $0.0166).

"The use of electricity in agricultural work may be classified as follows: (1) About the barnyard, as working the chaff cutter, corn cleaner, bruising mill, hauling crane, etc., unloading of hay, and, on large farms, smithy and cartwright work, and, further, for lighting the stables and the houses; and (2) in the fields, pulling the plow, running the machines, reapers, etc., and thrashing.

"There is no difficulty in installing the machines referred to in the farmyard, but the expense for the use of electricity in the fields is much too high as yet. The strong conductors and cables are too expensive, and the plow run by electricity does not as yet work satisfactorily. I feel sure that electrical centers will soon be installed in the country, and that the electrical energy thus provided will be employed first of all for agricultural work."

Swedish Electric Traction.

An item in our issue for Aug. 1, page 222, called attention to the conclusion of the experiments conducted by the Swedish government railway authorities with a view to determining the most advantageous system of electric traction to be adopted, as outlined on page 247 of our issue of Aug. 8, 1908. The result of these experiments are discussed in a report recently submitted by Chief Engineer Dahländer to the Swedish Parliament.

It is interesting to note that the advantages of the single-phase system over the three-phase system with respect to the overhead equipment in particular, were considered sufficient to warrant experiments being carried out with the single-phase system only. Under the conditions prevailing in Sweden the cost of the overhead equipment must play an important part in deciding selection of the system, and it was estimated that a 10,000 or 15,000-volt single-phase system would cost less than a 3000- or 5000-volt three-phase system.

Various methods of suspending the contact wire were tried, the most satisfactory being apparently the simple method of fixing the contact wire direct on to a swinging bracket without either suspension or cross wires. It was found necessary, even with catenary suspension, to put the contact wire under a certain amount of tension to ensure satisfactory current collection, and owing to the wide variations in temperature the method adopted on the Hamburg-Altona line of putting the wire under a constant tension by means of a hanging weight was resorted to. A constant tension of about 8 kg per square millimeter was employed. The well-known Oerlikon method of suspension was also used on one portion of the line. For section insulation the arrangement of parallel or crossed wires with air insulation was found to be more satisfactory than porcelain section insulators, partly on account of the weight of the latter, but chiefly due to the reduction of the insulating property of the porcelain by smoke and dirt. The brown porcelain insulators were provided with iron pins which were cemented into the insulator with a cement composed of from 15 to 17 per cent water-free glycerine and from 83 to 85 per cent litharge. It was noticed that insulators in contact with the live wires kept themselves free from soot, which was thickly deposited on other insulators. The current collector used in the Oerlikon system was found to wear quickly in spite of the low pressure of 0.7 kg, and this system was considered dangerous for use in stations as the contact wire must be suspended only just above the locomotive in the center of the track when in stations. As the speed of the trains was limited, on account of the nature of the track, to 70 km per hour, no experiments at high speeds could be carried out.

Extensive investigations were made in connection with the use of the rails as a return conductor. These showed that a large portion of the current was carried by the earth, this amounting, in some cases when the earth was moist, to as much as 80 per cent. A difference of phase existed between earth and rail currents, the measured power factor for the rails being in a few cases as low as 0.3. An attempt to increase the earth-current, by means of artificially grounding the rails, failed completely. A number of tests showed that at 25 cycles with a rail weighing 49.5 kg per meter, the rail resistance without copper-bonding amounted to from 0.1 to 0.2 ohm per kilometer of line, the resistance varying with the moisture of the ground.

The telegraph and telephone lines adjacent to the track were not seriously affected, owing chiefly to the short length of track. In one case, however, a particularly well insulated telephone line was charged to a potential of 5000 volts when using a contact-wire e.m.f. of 20,000 volts. This static charge was easily avoided by connecting discharging coils between the lines and earth.

The rolling stock used for the experiments consisted of a 300-hp Westinghouse locomotive, a 300-hp Siemens-Schuckertwerke locomotive, two motor-cars each rated at 230 hp supplied by the Allgemeine Elektricitäts Gesellschaft, and two trailers. Each locomotive or motor-car has run more than 10,000 km in the course of the experiments, and the electrical equipment has given every satisfaction. No trouble was experienced with the commutators of the single-phase motors. The forced lubrication of the A.E.G. motors effected a considerable saving in oil. It was conclusively proved that forced ventilation is very effectual in increasing the capacity of the motors and keeping the temperature low. The cable method of leading in the high-tension current was found unsatisfactory at high pressures, and a bare wire passing through the open window or through a porcelain collar was resorted to. The energy consumption varied between 13.9 watt-hours per ton-kilometer for a 265-ton train and a speed of 31.4 km per hour to 19.8 watt-hours per ton-kilometer for a 144.5-ton train and a speed of 48.2 km per hour. These values may be taken as relating to a level track, as the short up-gradients on the experimental track were compensated for by the corresponding short down-gradients. The momentum gained on the latter served in most cases to overcome the extra resistance due to the former. Experiments were also made in order to determine the relative costs of electric and steam car-heating. The power consumption for electrically heating a passenger car was found to be from 0.2 to 0.3 kw per degree centigrade difference between inner and outer temperatures. In order to compete with steam heating, the price of electrical energy would have to be not over 1 cent per kw-hour. With regard to the most favorable frequency of the single-phase current, the opinion is expressed in the report that a frequency lower than 25 cycles would have more disadvantages than advantages, even considering the possible better working of the motors. The frequency for which the plant was designed, 25 cycles, would seem to be the best.

In conclusion, the report states that the experiments have shown that the single-phase system can be considered as the simplest, cheapest, and most satisfactory system for main line working, and that there is little chance of a better system being devised in the near future. The immediate commencement of the electrical equipment of the main lines and the utilization of the country's water falls for supplying the energy are recommended.

The track on which the experiments were made comprised a 6-km stretch between Tomteboda and Värtan, and a 7-km stretch between Stockholm and Järfva. The electric trains have now been temporarily replaced by steam-driven trains, which will continue the service until electrical energy can be obtained from a water-power station. During the experiments energy was supplied from a steam-driven power-station. The electrical equipment of the track between Järfva and Värtan is, however, kept ready for use for demonstration purposes. At present the authorities are engaged with the design of the equipment for the main lines.

Destruction of Wooden Electrical Poles.

The United States Bureau of Forestry reports that birds are destroying the telephone and telegraph poles in the South and Southwest, particularly in Texas, Arizona and California. In some places 50 per cent of all the poles along the right-of-way have been riddled by these innocent offenders, which belong to the woodpecker family. One of the Western Union officials, who has recently returned from an inspection through the West, reported having seen 25 telephone poles with 200 or 300 holes drilled clear through them. Some of the holes were 3 in. or 4 in. in diameter. An officer of the Illinois Central Railroad counted the white cedar telephone poles along the right-of-

way, near Covington, Tenn., which had been affected by woodpeckers, and found that out of 268 poles, 110, or 41 per cent, had been bored.

In some cases destruction of the pole takes only a few months, and the weakened condition makes it dangerous for a lineman to climb the stick. The real object of the birds in drilling the holes is uncertain. One telephone man stated that the humming of the wires was mistaken by the birds for insects excavating beneath the surface of the wood, and that they drilled the poles in quest of these imaginary insects. It is very probable, however, that the holes are excavated for an entirely different purpose. The woodpecker is a provident bird. At the proper season it stores up a supply of acorns and other foods for future consumption. In the summer these holes are often found stored with acorns.

Many methods for preventing this damage have been suggested, but probably the most successful is preservation with creosote. A line of creosoted poles, opposite the one near Covington, was examined, and not a single hole was found. When it is considered that creosote will not only prevent the damage caused by the woodpecker, but also protect the pole indefinitely against both insects and decay, its great value as a preservative is apparent.

The Forest Service has spent considerable time in developing a cheap yet efficient method for the treatment of telephone and telegraph poles. The results of the work are embodied in several forest service circulars, copies of which may be obtained without cost from the Forester, Washington, D. C.

The Atlantic Cable of 1858.

BY WILLIAM MAVER, JR.

The development of trans-Atlantic cable telegraphy was not by any means the work of a day; in fact, it had been led up to step by step, and not until many shorter seas had been successfully bridged by submarine cables was the question of a cable across the Atlantic seriously mooted. It is true that as early as 1843 Morse, as a result of experiments that he had made in telegraphing over a circuit about 80 miles in length, wrote as follows to the Hon. John C. Spencer, then Secretary of the Treasury of the United States: "The practical inference from this law is that a telegraphic communication on the electromagnetic plan may, with certainty, be established across the Atlantic Ocean! Startling as this may now seem I am confident the time will come when this project will be realized."

This, however, was obviously nothing more than a happy prediction, for at that time no proper means of insulating wire for submarine telegraphy were at hand. Guttapercha, which nature appears to have especially provided for this purpose and without which submarine cable telegraphy would have been next to impossible, was not then known as an insulator. Indeed, specimens of guttapercha were not introduced into Great Britain until 1843, and the material did not reach the United States until 1847, where its property as an insulator for submarine cables appears to have been discovered, or at least developed, by Mr. S. T. Armstrong, of New York.

With the advent of a suitable insulator for submarine cables it was natural that attempts should be made to connect countries separated by stretches of water, by means of the electric telegraph, and within a short time after the discovery of guttapercha plans were being made to connect Great Britain and France telegraphically.

The concession for this cable was obtained from the respective governments by Mr. Jacob Brett on Aug. 10, 1849, with the condition that the work must be completed before Sept. 1, 1850. The cable for this purpose consisted of a No. 14 copper wire, covered with guttapercha to a thickness of about ¼ in. No armor or jute was placed over the cable, but to insure its remaining at rest on the bottom of the sea, lead sinkers, weighing 25 lb. each, were attached to the cable every one-sixteenth of a mile. In order to comply with the conditions of the concession the work of making and laying the cable was prosecuted with all possible celerity, and on Aug. 27, 1850, just three days before the expiration of the concession, Dover, England, and Calais, France, were for the first time telegraphically united, and messages of felicitation upon the happy completion of the work were exchanged amid the joyful acclaims of the inhabitants of both countries.

But the operation of this cable was short lived, a fact not to be wondered at in view of the manner of its construction, and subsequent investigation by divers showed what now appears might have been foreseen, namely, that where the cable hung over ledges on the bottom of the sea, the chafing of the lead weights had worn away the guttapercha, exposing the bare conductor.

"It was no wonder," said a writer of the period, "that the cable was cut, it being no thicker than a lady's stay lace, while it ought to have been as thick as the cable of those placed in the Britannia tubes in position, say 8-in. or 10-in. cable, and to be submerged below five fathoms, by the aid of enormous weights, so as to avoid all currents."

It is but fair to say that even the projectors of the enterprise themselves were not surprised at the unfortunate termination of the work, regarding it more in the nature of an experiment than otherwise. The results of this experiment showed conclusively that a properly constructed cable would prove successful between these points, and the energies of engineers and manufacturers were devoted promptly to designing a cable to meet the requirements. The form of cable next determined on was a four-conductor cable in which the guttapercha insulation was protected by a jute covering over which was placed an armor of galvanized iron wire. A cable constructed according to this plan was successfully laid between Dover and Calais, Oct. 17, 1851. The length of this cable was 25 miles. Its total cost was $75,000. Its operation was a complete success, and in the course of a comparatively short time London and Paris were exchanging messages directly; that is, without the aid of intermediate stations.

The inauguration of the Dover-Calais cable gave incentive to the laying of numerous other submarine cables in Europe and America, with the result that before the year 1857 there were, exclusive of short cables across rivers, nearly 1000 miles of cable in operation in those countries, the longest of which was that between England and Holland, 115 miles. Four hundred miles of cable had also been laid between different ports of the Black Sea during the Crimean War and by means of which the respective countries interested were kept in electrical communication with the seat of war, a great desideratum at that time.

The successful operation of these numerous but comparatively short submarine cables naturally suggested to many minds the possibility of trans-Atlantic submarine telegraphy. There were others, however, who were fearful that the difficulties in the way were too great to be surmounted. As Dr. Lardner wrote at the time (1855): "The sanguine consider the project practicable, and its speedy realization probable. The more phlegmatic notice it only with ridicule. Men of science generally admit the possibility of a remunerative result." Others, imperfectly informed, believed that the cable would not sink below a certain depth, at which the increasing density of the sea water would render it, bulk for bulk, as heavy as the cable. This view, however, was erroneous for the reason, as pointed out at the time by the same writer, and as subsequent experience has shown, that water is susceptible of compression in so slight a degree that even at the greatest depths of the ocean the cable must always greatly exceed the sea water in specific weight. There were others also like Shaffner in our own country who had no faith "that a telegraphic cable laid in the ocean 2000 miles could be made available for practical telegraph purposes with the present known sciences." Shaffner doubtless had in mind the retardation of signals due to the static capacity of cables and there is no doubt that if the "known sciences" of overland telegraphy at that time had not been improved upon in long-distance submarine telegraphy his lack of faith in that art for "practical telegraph purposes" would most likely have been justified.

Prominently, if not initially, among those who were instrumental in pushing the project of trans-Atlantic telegraphy into the open, impartial history requires that the name of Mr. F. N. Gisborne, an Englishman in the telegraph service at Montreal, must be mentioned. As early as 1852, or immediately following the success of the Dover-Calais cable, he appears to have become imbued with the belief that a trans-Atlantic cable from Newfoundland to Ireland was a possibility, and with that end in view set about to obtain the means to construct the necessary intermediate cables between New Brunswick and Prince Edward Island, thence to Newfoundland. Only partially successful in his endeavors he came to New York in the spring of 1854 to exploit his schemes and was so fortunate as to meet Mr. C. W. Field at the hotel where he was stopping. In Mr. Field he found an attentive listener and from that moment began Mr. Field's historical association with the ultimately successful accomplishment of trans-Atlantic telegraphy.

One of the first acts of Mr. Field when his attention was called to the project was to communicate with Lieutenant Maury, then Director of the National Observatory of the United States, requesting his views as to the possibility of immersing a cable between the old and the new world. He also communicated with Professor Morse, soliciting his opinion as to the practicability of transmitting signals electrically over a distance equal to that separating Newfoundland and Ireland, namely, 1950 miles. In both of these inquiries affirmative replies were received, whereupon he at once undertook the organization of a company to raise the necessary funds to put the project into execution. The company, known as the New York, Newfoundland & London Telegraph Company, was organized in 1854, and was immediately successful in its efforts to raise capital, and the remarkable interest taken in the enterprise by the people and the governments of the countries and states concerned is well exemplified by the manner in which money, land, landing rights and the free use of war vessels for the laying of the cable was bestowed on the company. The government of Newfoundland, for instance, gave the cable company exclusive privileges for 50 years of landing cables on Newfoundland, Labrador and their dependencies, and it may be recalled that these privileges were invoked when the Marconi Wireless Telegraph Company recently sought to erect a wireless station in Newfoundland. The same government also guaranteed interest on the bonds of the company to the extent of $250,000, together with a grant of 50 square miles of land on the Island of Newfoundland. The governments of Prince Edward Island, of the State of Maine and likewise the governments of Great Britain and the United States, gave grants of exclusive landing privileges and subsidies of large amounts of money. The capital stock of the company, $1,750,000, was quickly subscribed for in America and Great Britain; and in a comparatively short time the contracts for the construction of the first Atlantic cable were given out, the work being divided equally between Messrs. Glass & Elliott, of London, and Messrs. R. S. Newall & Co., of Birkenhead, England. Great care was exercised in the design of this cable, every precaution being taken to avoid the defects of previous shorter cables and to provide for the severer conditions that its greater length and the greater depths of ocean in which it was to be submerged would involve. If the cable were too heavy the previous experience of Mr. John Watkins Britt with a heavily constructed cable between France and Algiers had shown that "the management of such an ocean cable would be an impossible undertaking." On the other hand, the experience with some of the earlier cables, notably the first Dover-Calais, had demonstrated that the attempt to utilize too light a cable would be useless. Hence a cable that would possess maximum strength and flexibility, combined with minimum size and weight, was designed. The conductor itself was a strand of seven No. 22 copper wires of the purest copper then obtainable. The outside diameter of the strand was 1/16 in. This strand was covered with three coatings of guttapercha to an outside diameter of 3/8 in. Over this was placed a coating of thread yarn, well saturated with a mixture of pitch, tar and oil. Around this core was wound an iron armor consisting of 18 strands of No. 22 iron wire, seven wires to a strand, or 126 wires in all.

The completed cable had a diameter of 3/4 in. The weight of this cable was 1860 lb. per mile. The shore ends of the cable were protected by much heavier armor and jute, and weighed approximately seven tons per mile. In short, it may be said that this pioneer cable virtually embodied all that has been found necessary in subsequent trans-Atlantic cables, except as to improvements in details of construction. The total length of the cable, including the shore ends, was 2535 miles, a large allowance for possible losses of cable being supplied. The cost of the cable was $1,258,250.

The cable having been completed, the portion manufactured by Messrs. Newall & Company was shipped on board the U. S. S. *Niagara,* while the portion from the works of Glass & Elliott was placed in the hold of the British ship *Agamemnon.*

After many preliminary festivities in celebration of the laying of the cable, upon the successful completion of which the thoughts of two continents were hopefully turned, the expedition set forth from Valentia Bay, Ireland, on Aug. 7, 1857, but after paying out 344 miles of cable from the *Niagara,* the cable parted, and the cable-laden ships despondently returned to Valentia; the unused cable was uncoiled from the holds of the *Niagara* and *Agamemnon* and for the time being operations were suspended.

Following this disaster the public mind became distrustful of the ultimate success of trans-Atlantic telegraphy and additional capital for further operations became difficult to raise. The directors of the company, however, continued firm in the belief that success was yet possible and during the winter of 1857-58 measures for a renewal of the enterprize during the following summer were vigorously promoted. The governments of the United States and Great Britain courteously granted the request of the company for the further use of the *Niagara* and *Agamemnon* and these vessels were once more got in readiness for a renewal of the undertaking. In the expedition of 1857 it had been arranged that the *Niagara* would lay her portion of the cable from Valentia to the middle of the Atlantic where she would be met by the *Agamemnon* which would then proceed with her part of the cable to Trinity Bay, Newfoundland.

This time it was arranged that both vessels should proceed to the middle of the Atlantic, where they would separate after splicing the ends of the cable together, the *Niagara* to proceed to Newfoundland, the *Agamemnon* to Ireland. In accordance with this plan the vessels met in mid-ocean June 26, 1858, and commenced paying out the cable. The ill success of the previous expedition still followed, however, and after several breaks in the cable, work was abandoned on June 29 and the vessels returned to the rendezvous, Queenstown, arriving at that port July 5, 1858.

Nothing daunted, however, and in the face of countless forebodings of continued ill success by a large portion of the public and press, the directors of the enterprise once more started the telegraph fleet to their meeting place in mid-ocean on July 17, 1858. The ships met as arranged and each proceeded to its destination. This time the laying of the cable was successfully accomplished, no mishaps having occurred from the moment the ships separated until they arrived respectively in Trinity Bay and Valentia.

The public had become so discouraged by previous failures that the announcement of the successful arrival of the expedition at Newfoundland, Aug. 5, 1858, was not immediately believed. Dispatches from Mr. Cyrus W. Field speedily convinced the most sceptical that the unexpected had happened, and the entire country gave way to rejoicings, and as a writer of that time put it: "Bells were rung, bonfires blazed, business ceased, illuminations sprang up, the press became jubilant. Rarely has there been heard so universal a shout of joy."

This it must be noted was upon the announcement of the safe arrival of the cable on the American shore. No public message had yet passed over the cable and it was not until Aug. 16 that the long expected message from Queen Victoria to President Buchanan was received. By some oversight or

delay in transmission only the first paragraph of the Queen's message was at first received and its apparent curtness caused great disappointment. This feeling was dissipated on receipt of the entire message the following morning, Aug. 17. The Queen's message was as follows:

"The Queen desires to congratulate the President upon the successful completion of this great international work, in which the Queen has taken the deepest interest.

"The Queen is convinced that the President will join with her in fervently hoping that the electric cable which now connects Great Britain with the United States will prove an additional link between the nations whose friendship is founded upon their common interest and reciprocal esteem.

"The Queen has much pleasure in thus communicating with the President, and renewing to him her wishes for the prosperity of the United States."

The reply of President Buchanan was as follows:

"The President cordially reciprocates the congratulations of Her Majesty, the Queen, on the success of the great international enterprise accomplished by the science, skill and indomitable energy of the two countries. It is a triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle.

"May the Atlantic telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the kindred nations, and an instrument destined by Divine Providence to diffuse religion, civilization, liberty and law throughout the world. In this view will not all nations of Christendom spontaneously unite in the declaration that it shall be forever neutral, and that its communications shall be held sacred in passing to their places of destination, even in the midst of hostilities."

It had been predicted by the engineers of the cable company as a result of experiments which they had made that a speed of at least seven words per minute would be obtainable over the Atlantic cable. From the fact that the Queen's message, containing just 99 words, had taken 67 minutes in its transmission it is evident that 7 words per minute were not realized. However, allowance must be made for the crudeness of the art and for the many disadvantages under which the engineers and operators were then laboring.

But, alas, like the first cable between Great Britain and France, this first Atlantic cable was also doomed to a very short useful existence. After the transmission of the messages to and from the Queen the signals over the cable became weaker and weaker until Aug. 31, 1908, when they failed utterly. Mr. C. F. Varley, the electrician of the company, was sent to Valentia to ascertain the cause of the non-working of the cable. He made a number of tests and reported that a fault of great magnitude existed at a distance of about 260 miles from Valentia. Mr. W. T. Henley, telegraph engineer, and Prof. W. Thoman, also carefully tested the cable during the month of September, but without success so far as obtaining readable signals through the cable was concerned.

It has been thought, and perhaps correctly, that the injury to this cable may have been due to the employment of high-tension currents from induction coils in signaling, and the view has been expressed that had only low-tension currents been employed, their utility for this purpose having been demonstrated by Mr. Latimer Clark, the injury to the cable might have been avoided. There is, however, no proof that the fatal faults in the cable were due to their high-tension currents, and it is not difficult to imagine that the inexperience in cable making at that time, together with the more or less crude methods of paying out the cable on ship-board, may have been sufficient to account for the cause and development of the faults in question. Furthermore, it is to be remembered that at this early period of long-distance submarine working, variable earth currents practically debarred the use of very weak currents for signaling. It probably was not until Varley's interposition of the condenser in the cable circuit, thereby obviating the disturbing effects of the earth currents, that recourse could be had to weaker signaling currents.

Whatever may have been the cause of the failure of the Atlantic cable of 1858 there is no doubt that its failure confirmed the opponents of trans-Atlantic telegraphy in their opinion as to its impracticability. So firmly were some of these opponents convinced on this point that the construction of an overland telegraph line between America and Europe via Behring Straits and Asiatic Russia was undertaken and over $3,000,000 were expended on this work before the final success of cable telegraphy was assured by the successful operation of the cables of 1865 and 1866.

Since that time submarine cable laying has gone on apace until all lands and continents are now joined together by these metallic threads. In 1880 there were about 51,000 miles of cables laid and working in various parts of the world. To-day there are 250,000 nautical miles of submarine cable in operation, and if cable laying now be at a lull it is only because there are no more waters to conquer. Indeed, singular to say, submarine cable telegraphy has shown itself able to supplant overland telegraphy between points not separated by water, but where the difficulties of construction and maintenance of overland lines are practically unsurmountable, as witness the electrical connection of many of the ports of South America and of the Philippines by long submarine telegraph cables.

In an impartial review of the events connected with the making and laying of the Atlantic cable of 1858, the jubilee of which is now being celebrated, as well as of the shorter submarine telegraph cables beginning with the Dover-Calais cable it would be unfair to omit mention of the important part, one might almost say the exclusive part, borne by British telegraph engineers and cable manufacturers, among which shine out conspicuously the names of Engineers Whitehouse, Varley, Thomson (Kelvin), Britt, Bright and Henley, and the manufacturers already mentioned. Of Varley especially it may be questioned whether he has yet received the credit due for his important early work in this relation.

CURRENT NEWS AND NOTES.

OPERATING TRAINS BY TELEPHONE NOT A SUCCESS.—The officials of the Richmond, Ind., division of the Pennsylvania Railroad say they have unsuccessfully tried the use of telephones for dispatching and do not regard them as good or as reliable as the telegraph. They say it is difficult to hear over the telephone when the weather is bad or when snow and ice accumulate on the wires. They also say that in transmission of messages words are often misunderstood.

PRACTICAL BENEVOLENCE.—Mankato, Minn., has been suffering recently from an epidemic of typhoid fever. Mr. R. E. Brown, the general manager of the Mankato Gas & Electric Company, issued a notice that the corporation would instal an electric fan free of any charge whatever for service, for any one who was ill enough to need it and was within reach of the circuits. The only thing necessary was to file a notice promptly through the physician in attendance. The weather has been very hot throughout the epidemic and the availability of this cooling device has been deeply appreciated.

THE TROLLEY IN JAPAN.—It is stated that to-day there are no cities of any note in the Japanese Empire that do not possess a system of electric tram cars, omnibuses or motor cars, and almost every important place or pleasure resort in the country is connected with the main cities by one of the means of locomotion mentioned, so that the capital invested in such undertakings has reached an enormous amount. There are eight trolley lines running, with an aggregate capital of $18,530,000 gold. Adding smaller companies and several enterprises not yet opened, the aggregate capital of all the lines—those in operation or about to be operated—reaches a total of over $50,000,000, with a mileage of 545.

TRANSMISSION IN CHILI.—The Empresa de Tracción y Alumbrado Electricos, of Santiago, is installing a 22,000-hp hydro-electric plant at La Florida, whence the electrical energy is to be transmitted to the city over an underground cable at 12,000 volts. This will be sufficient to light and supply power for the works of the city for many years to come. The installation is principally German.

MUNICIPAL PLANT A BAD BARGAIN.—Last fall the Town Council, of Washburn, Wis., purchased the electric lighting plant of the Washburn Electric Light & Power Company, and the municipality has had such an unsatisfactory experience in operating it that measures have been taken to force the original owners to take back the property. The lighting committee of the council has been directed to annul the sale and compel the return of all money paid for the plant, but the courts will be called upon to decide if such an autocratic use of power is legal.

GREAT NORTHERN RAILROAD CASCADE POWER PLANT.—In a note in our issue of Aug. 8, page 287, on the plant now being constructed to supply electric power for three-phase traction over the Cascade tunnel section of the Great Northern Railroad, an error appeared in the statement relating to the turbines. The hydro-electric equipment will consist of three "Victor-Francis" turbines, built by the Platt Iron Works Company, Dayton, Ohio, and regulated by Sturgess governors, direct-connected to General Electric three-phase generators. There will also be two 200-hp exciter units.

OCEAN WEATHER FORECASTS.—A recent visitor to this country is Dr. Peter Polis, head of the meteorological observatory at Aachen, Germany, and one of the foremost meteorologists of that country. He comes as the representative of the German government to consult with and interest the Department of Agriculture with a view of establishing a system of wireless weather reports from ships at sea, so that a daily report may be made of the weather on the Atlantic and prognostications made just as on the land. It is the intention to establish co-operation between the weather services of the two governments.

AMERICAN CHEMICAL SOCIETY.—An important step in the development of engineering chemistry in this country was taken at the recent New Haven meeting of the American Chemical Society by the organization of a Division of Industrial Chemists and Chemical Engineers. Arthur D. Little, of Boston, was elected chairman of the division and vice-president of the society, and indicated in his address the broad field awaiting development by the new organization. The division will include a large proportion of the membership of the society, especially engineering chemists whose work is directly concerned with industrial development and progress. The division will begin the publication at an early day of a journal, for which a strong board of editors was elected.

LIQUEFACTION OF HELIUM.—In a communication to the Amsterdam Academy concerning the liquefaction of helium Professor Onnes describes in detail the steps that led up to the achievement, the complicated apparatus that he employed, and the difficulties that had to be overcome in order to lower the temperature to within a very few degrees in the neighborhood of the zero of absolute temperature, which so far has been fixed at 273.1 deg. below the centigrade zero. In spite of the most elaborate and comprehensive preparation and ample supplies of liquid hydrogen, not only was the whole apparatus tested to its utmost capacity, but the physical energies of the professor and his assistants were well nigh exhausted by the prolonged struggle. Professor Onnes holds that the critical temperature at which helium liquefies is not much higher than 5 deg. above the absolute zero, and says that more careful measurements and calculations must be made before any certain and final conclusion can be reached. At temperatures so near to the absolute zero there is always room to doubt the application of laws deduced from the behavior of bodies in more normal conditions.

NEW YORK ELECTRICAL SHOW.—The electrical show which is to be given in Madison Square Garden, Oct. 3 to 14, under the auspices of the lighting companies of Greater New York and vicinity bids fair to be on a large scale and very successful. It will commemorate the jubilee of the laying of the first submarine cable, of 1858, and the completion of 25 years of continuous electric service on Manhattan Island. Mr. Thomas A. Edison has taken the honorary presidency, and the vice-presidents are leading men in the industry. One day has been set aside for charity, and the proceeds will go to the Loomis Sanitarium for consumptives. Oct. 10 has been set aside for special entertainment and exercises by the Sons of Jove, and plans are making for other meetings, lectures, etc.

PERPETUAL MOTION IN INDIANA.—The Industrial Club, of Alexandria, Ind., an organization of citizens to boom their town, has embarked as an active partner in an enterprise which recalls the days of the Keely motor. The club has entered into a contract with a concern whereby land, buildings and $25,000 in cash will be given to the latter, known as the Continuous Water Power Company, as a bonus for locating at Alexandria and there manufacturing the apparatus of a system for creating energy, which is described as follows in the articles of agreement between the club and the promoters of the system, W. B. Gray, G. Fox and F. M. McKay: "Said continuous water-power motors shall generate within themselves a power without the use of coal, gas or electricity or any other auxiliary power; said motor and equipment shall be capable of delivering all of the water taken from the tower, in return to the town, and shall not use in so doing to exceed an equivalent of 25 per cent of the power derived from the water taken primarily," which appears to be another form of the problem how to lift oneself over a fence by his boot-straps. The agreement is signed by Perry Heritage as a trustee of the club, but it appears that the citizens of Alexandria, at a mass meeting held on July 17, gave their endorsement to the project, thereby registering their opinion of some local theorists who had ventured to criticise the scientific basis of an invention which leading citizens had examined and found to be entirely correct in principle and engineering design.

TELEGRAPHIC DISCONTENT.—Advices from Washington give the terms of the agreement between officials of the Chicago, Rock Island & Pacific Railroad Company and officials of the Order of Railway Telegraphers, representing the railroad company's force of operators, in regard to the controversy over an interpretation of the nine-hour act. Chairman Knapp, of the Interstate Commerce Commission, and Commissioner Neill, of the Bureau of Labor, who constitute the board of mediation under the Erdmann act, acted as intermediaries between the parties. The agreement averts all danger of a strike. The dispute arose over the insistence of the railroad company that the hours of work of its operators should be split, while the telegraphers contended that the correct interpretation of the law meant that the operators should work nine consecutive hours per day. The agreement provides that in day and night offices where two telegraphers are employed nine hours of total service in a 12-hour spread, commencing at or between the hours of 6:30 and 7:30 a. m. or p. m., shall constitute a day's work, and that in no case shall the nine hours be separated into more than two periods. Where three operators are employed nine hours of total service in an 11-hour period shall constitute a day's work, but in no case shall the nine hours be separated into more than two periods. Ten consecutive hours, including one hour off duty, shall constitute a day's work for all telegraphers employed in the offices designated as under the jurisdiction of the superintendent of telegraph. The salaries of all telegraphers at Chicago and Topeka are increased to $77.50, $80 and $85 per month.

Interconnected Hydro-Electric Generating Stations.

AT Bilbao, an industrial town in the northern part of Spain, on the Bay of Biscay, a company known as Sociedad Hidroelectrica Iberica was formed to build several hydro-electric stations to supply the town with energy for lamps and motors. This was done to supersede a number of small steam plants running under unfavorable conditions, particularly in regard to the exorbitant price of coal. The company owns at

FIG. 1.—POWER PLANT AT LEIZARAN.

present three plants: one at Leizaran, about 48 miles east of Bilbao, with a rating of 4000 hp; one at Puentalarra, about 34 miles south, with a rating of 8000 hp, and one at Quintara, 37 miles southwest, with a rating of 4000 hp.

Besides supplying the immediate vicinity with energy, there is run from each main station, except Quintana, a line to the receiving station at Bilbao having a rating of 6800 kw. A line runs northward from Leizeran to Sebastian, about 8 miles distant, supplying energy to the town at the rate of 850 kw, while another runs southward to Tolosa, 6½ miles distant, supplying the town with 250 kw. On the main line from Leizeran to Bilbao, there is located at Bosconio a substation equipped for receiving 1700 kw.

From the Puentalarra plant to Vitaria is a line running northeastward supplying the town with 500 kw. This line is 20 miles long. South to Puentalarra, at Miranda, is a substation containing a 250-kw equipment. From the main line to Bilbao

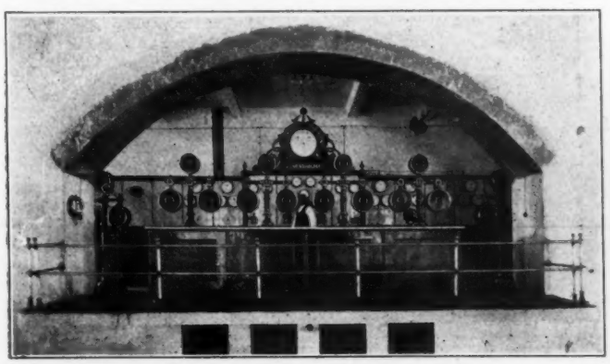


FIG. 2.—SWITCHBOARD AT LEIZARAN PLANT.

there is a branch to Aronguren, utilizing a 850-kw equipment. On the line from Quintana to Bilbao is a branch running to Arrigorrioyo, with equipment rated at 850 kw. The total length of the whole transmission system is 210 miles. The e.m.f. is between 33,000 and 50,000 volts.

LEIZERAN PLANT.

The Leizeran plant is located near the watering-place San Sebastian and utilizes the water of the Leizeran, a stream in the Pyrenees. There are at present installed four 1000-hp impulse wheels, directly-connected by insulated flexible coupling to 565-kw, 50-cycle, 3300-volt alternators running at 375 r.p.m. The bedplate of the generator frame is made of structural steel, because the machinery had to be imported from Germany. The plant also contains three 50-hp exciter units.

The switchboard, which is located at one end, is divided into two stories; the lower one contains the instruments for the generators, and the upper one the controlling bench and switches for outgoing feeders.

The generator e.m.f. of 3300 volts is stepped up through four banks of transformers, each bank being connected in star. Each transformer is rated at 285 kw. The oil switches are of the remote-hand-control type; on the low-tension side, the

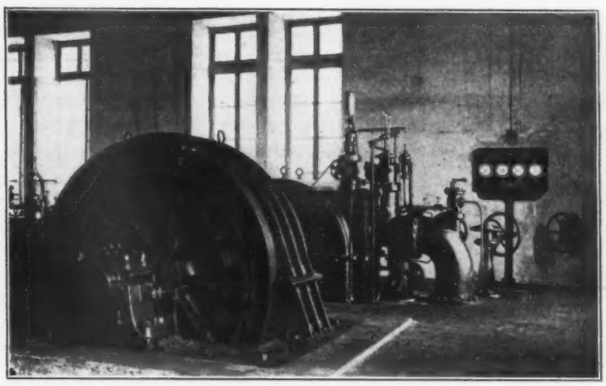


FIG. 3.—TURBO-GENERATOR SET AT LEIZARAN.

switches have four contact points and on the high-tension side eight. The outgoing feeders are well protected by horn lightning arresters and choke coils.

QUINTANA PLANT.

The Quintana plant is located near the railway station Miranda de Ebro on the line from Jrun to Madrid. It utilizes the water from the River Ebro. There are four 1000-hp Francis turbines, running at 375 r.p.m., having a draft tube 23 ft. long. The generators, exciters, etc., and switchboard are the same as those at Leizeran.

PUENTALARRA.

The Puentalarra plant, which is located 13.5 miles downstream from Quintana, utilizes the water of the same river (Ebro). For this purpose there had to be built a head race 9.5 miles long, including 14 tunnels, with a total length of 2600 ft.,

FIG. 4.—HEAD RACE OF THE PUENTALARRA PLANT.

and much filling had to be done. The tunnels are 20 ft. wide and 13 ft. high. The equipment of this station varies but little from those of the others, as all of them were designed at the same time by the same companies. The mechanical equipment was furnished by Escher-Wyss Company, of Zurich, Switzerland, and the electrical by Siemens-Schuckert Werke, Berlin. As the station is of 8000-hp rating, each of the four transformers is rated at 2000 hp.

SUBSTATION AT BILBAO.

Each of the 30,000-volt feeders from the three generating stations is provided with a busbar system. In the basement of the substation are located eight banks totaling 24 oil-cooled transformers, each of 285 kv-amp rating. They serve to decrease the e.m.f. from 30,000 down to 3000 volts for local distribution. The station is well equipped with up-to-date electrical accessories.

MARKLISSA HYDRO-ELECTRIC STATION.

The Marklissa power plant at Selicia, Germany, utilizes the water of the River Queis, which is a branch of the Bober. The

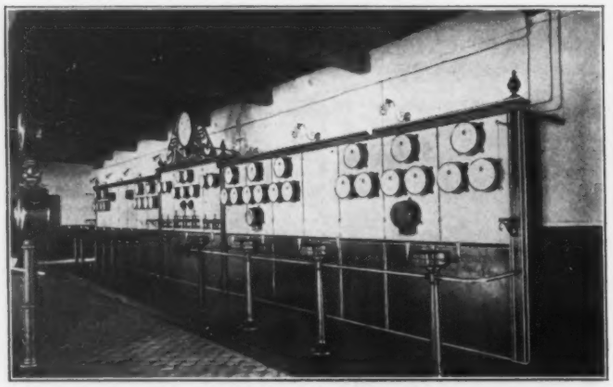


FIG. 5.—MAIN SWITCHBOARD AT PUENTALARRA.

plant is located about two miles downstream from the city of Marklissa, and is the property of the Provincial Union of Selicia. It supplies energy for lamps and motors to the vicinity within a radius of eight miles. It is intended to operate this plant in parallel with that at Mauer, 18 miles distant, utilizing the water of the Bober. These two plants, after completion, will work in conjunction with a steam plant at Waldenburg, 38 miles away. The plant at Marklissa has a water-storage space of 550 million cu. ft., while that at Mauer has 1800 million. Aside from the auxiliary plant at Waldenburg, the two water-power plants have sufficient water supply to guarantee continuous service to all three districts. The plant at Waldenburg will act only in case of emergency.

It might be of interest to state that for a number of years Germany has been compelled to take advantage of any water-falls available for power purposes, because of the limited supply of coal. Tributaries of streams are entirely cut off by dams near the junction with the receiving stream. These dams are built high enough to store the entire drainage for the year. Although a spillway is provided, no water flows over except in cases of extreme flood. The dams are provided at the bottom with waste gates, and allow only a minimum amount of water to pass through. In case of emergency, the entire basin may be drained. This system of construction is made use of only in valleys; the dam runs from one mountain slope to the other, thus cutting off the entire valley below the dam, from which the name "Talsperre" (valley cut off) is derived. In the last few years there have been built in Germany and other countries in Continental Europe several notable plants on this principle, de-

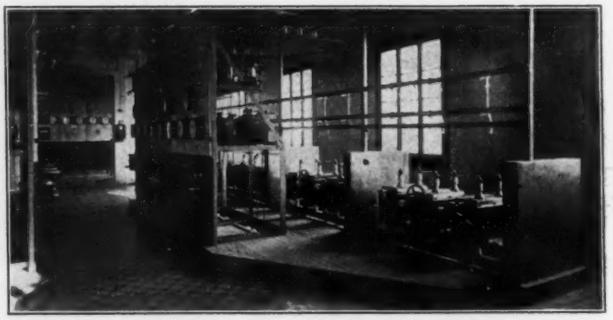


FIG. 7.—SWITCHBOARD FOR TRANSFORMERS, 33,000-VOLT TRANSMISSION AT PUENTALARRA.

livering energy for lamps and motors over a large area, from water which heretofore was entirely wasted.

Fig. 9 shows the Marklissa dam and the power plant located in front of the dam in the valley. From the dam lead two steel penstocks, 47 in. in diameter, to the power house, about 350 ft. distant. In the power house they are interconnected by a 67-in. penstock, from which branches run to the turbines. The power house has been designed to accommodate five 715-hp units. At present only three are installed. They are of the Francis type made by Voith, Heidenheim; under a head of 85 ft. they use 97 cu. ft. per unit. Each turbine is directly connected to the generator through an insulated flexible coupling. To preserve a uniform torque a heavy fly-wheel is mounted on the shaft between the coupling and the turbine.

The generators, furnished by Siemens-Schuckert Company,

FIG. 6.—INTERIOR OF GENERATING ROOM AT PUENTALARRA.

are of three-phase-revolving field, 50-cycle, 10,000-volt machines each being rated at 620 kw. There are a 35-hp exciter unit and a 64-kw motor-generator set.

At one end of the generating room, upon a mezzanine floor,

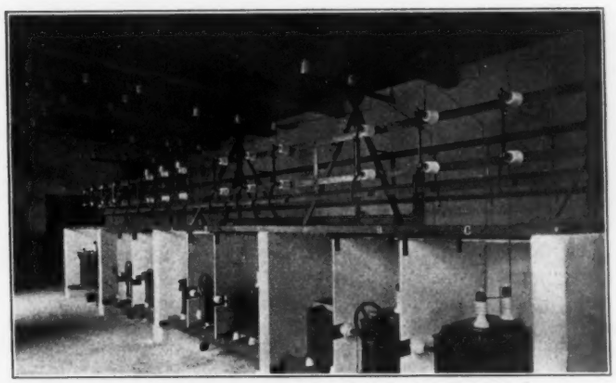


FIG. 8.—33,000-VOLT SWITCHROOM AT LEIZARAN.

is located the switchboard, with a skeleton iron frame and with seven white marble panels. In front of the switchboard are six instrument columns, one for each generator, which contain

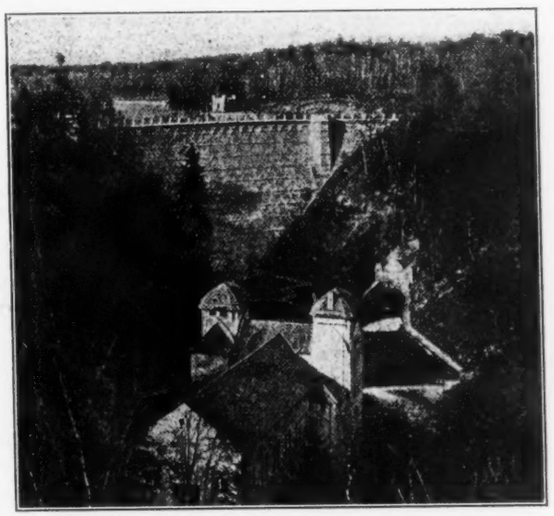


FIG. 9.—MARKLISSA POWER PLANT AND DAM.

the necessary instruments for controlling the generators. Mounted on the side of the switchboard is a recording water-level indicator. Energy can be drawn from either of two bus-

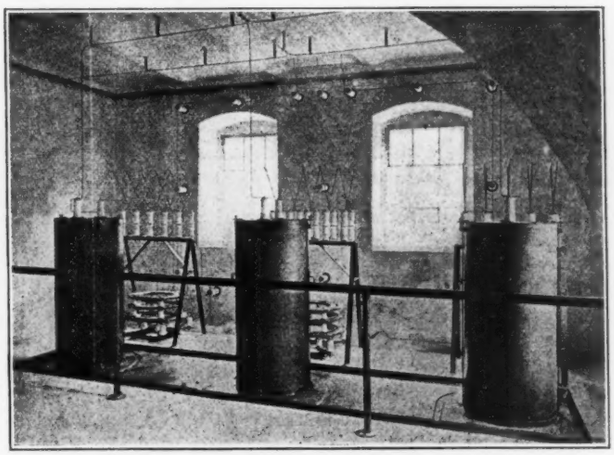


FIG. 10.—PROTECTIVE DEVICE FOR OUTGOING LINES.

bar systems, which are well provided with disconnecting switches. The generator and feeder switches are of the remote-control oil type.

All high-tension apparatus is placed in fireproof compartments. Fig. 10 illustrates apparatus for outgoing feeders, while Fig. 10 shows protecting devices for outgoing feeders. In the front are three oil resistors; behind on four racks are horn-type lightning arresters; underneath them are choke coils placed in layers.

From the power house energy is sent over three circuits without transformation. One line, to Marklissa, is two miles long; one to Laubau, 6½ miles long, and the other, to Greiffenburg, 8½ miles long. At these stations the e.m.f. is stepped down to 220 and 120 volts. Another circuit runs to Mauer and Waldenburg. At Mauer a transformer station has been erected where the 10,000-volt generator e.m.f. will be stepped up to 20,000 and possibly 30,000 volts to supply energy to Waldenburg.

The plant at Marklissa has been in operation since December, 1907. The entire electrical equipment of the power plant, transmission line and substations was supplied by Siemens-Schuckert Werke, Berlin.

The Synchronous Motor in Systems Operating at Low Power Factor.—I.

By F. C. Helms.

THE alternating current differs from the direct current in that the current flowing in a circuit upon which an alternating e.m.f. is impressed may have any phase relation with respect to the impressed e.m.f. depending upon the nature of the transmission line, feeder circuits and the apparatus taking current from the latter.

Induction motors, transformers and arc-lighting apparatus take a certain amount of exciting current which lags behind the impressed e.m.f. Condensers and cables, and sometimes long transmission lines, take a certain amount of charging current which leads the impressed e.m.f. The synchronous motor has the well-known property of taking current from the line, which may have any desired phase relation with respect to the impressed e.m.f., depending only upon the strength of the field, which is excited from a separate direct-current source.

If a mill or factory requires a certain number of foot-pounds of energy per minute (or horse-power) to do the work, and if the machinery is to be driven by electric motors, the equipment should be so designed as to produce this mechanical energy with the investment of the least possible amount of capital in equipment, and with the expenditure of the least amount of electrical energy as losses in producing it.

It is the object of this paper to point out briefly some of the more important effects of low power factors upon the electrical equipment, and the cause of these low power factors, with a more complete investigation of the synchronous motor as used for improving the power factor of generators and transmission lines feeding energy to inductive systems.

EFFECTS OF LOW POWER FACTORS, CAUSED EITHER BY LAGGING OR LEADING CURRENTS.

The effects of low power factor will be discussed in connection with a concrete case so as to make it more definite and clear.

Suppose a mill, requiring 1000 kw of actual power for driving machines and for lighting by means of arc lamps, is located in a city and fed with energy by a transmission line 10 miles long, at the other end of which is the generating equipment. Assúme that the generating station has generators and prime movers capable of delivering 1000 kv-amp at any power factor from 0.70 to 1.00, and that the transmission line is capable of carrying the current corresponding to 1000 kv-amp with an I^2R loss of 10 per cent, a voltage drop due to resistance of 10 per cent, and a reactive drop of 20 per cent of the generator e.m.f. The diagram, Fig. 1, shows the combination of the resistance and reactance voltage drops with the generator terminal e.m.f. to produce the receiver or terminal voltage OC at the end of the line.

If the combined power factor of all the apparatus in the mill is 70 per cent (lagging current) then $1000 \div .7 = 1430$ kv-amp must be delivered to the mill. Trouble is apparent at once as

the extra wattless lagging current will increase the component of the IR drop in phase with the terminal voltage by approximately (43 × 0.70) 30 per cent, and the component of the *IX* drop in phase with the terminal voltage will be (0.43 × 0.71 × 0.20) or 6 per cent, although it was zero at 100 per cent power-factor. Hence there will be a voltage drop of 19 per cent at 70 per cent power-factor, while there was only 10 per cent at 100 per cent power-factor. The I^2R losses in the line and generator will have increased by 105 per cent so that there will be 20.5 per cent loss at 70 per cent power-factor, where there was only 10 per cent at 100 per cent power-factor. The lagging current in the generator will not only increase the I^2R losses in the armature by 105 per cent, but a larger field current will be required due to the demagnetizing action of the lagging current. The increase in the field excitation, due to the increase of 43 per cent in the armature current, which is now lagging by 45 electrical time-degrees behind the terminal e.m.f. instead of being in time-phase with it, can only be determined when the ratio of the synchronous impedance ampere-turns to the ampere-turns required on open circuit at the voltage corresponding to the internal voltage under the full load is known. In case the synchronous impedance ampere-turns at the current corresponding to 1000 kw at 100 per cent power-factor are equal to 25 per cent of the field ampere-turns required for exciting purposes, then the total field ampere-turns required for 1430 kv-amp, 70 per cent power-factor, will be approximately 30 per cent greater than that at 1000 kw 100 per cent power-factor, while the I^2R losses will be 70 per cent greater. Again, if the synchronous impedance ampere-turns at 1000 kw 100 per cent power-factor are equal to 50 per cent of the excitation ampere-turns, then the total field ampere-turns required for 1430 kv-amp 70 per cent power-factor will be approximately 50 per cent greater than that required for 1000 kw at 100 per cent power-factor, and the I^2R losses will be 125 per cent greater. These conclusions are derived from the curves shown in Fig. 10.

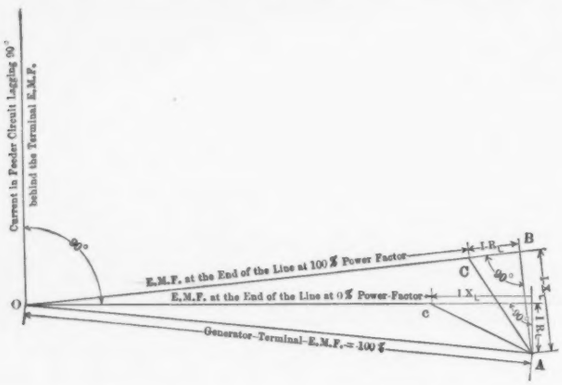

Current in Feeder Circuit Lagging 90°
behind the Terminal E.M.F.
E.M.F. at the End of the Line at 100% Power Factor
E.M.F. at the End of the Line at 0% Power Factor
Generator Terminal E.M.F. = 100%
I R
I X
O
A
B
C

FIG. 1.—DIAGRAM OF COMPONENT AND RESULTANT E.M.F'S.

If an attempt is made to maintain the voltage constant at the end of the line it is evidently necessary to increase the generator voltage by 9 per cent, which would not only increase the core loss in the armature, but would increase the field current a great deal more than 9 per cent, depending, of course, upon the saturation of the magnetic circuit. If, when the generator is running so as to deliver 1470 kv-amp at 70 per cent power-factor with a constant terminal voltage, the load on the system should suddenly be removed by accident, the voltage at the end of the line might rise to a dangerous value.

In summing up the evil effects of low power-factor it is to be noted that if the actual power remains constant at all power factors the *IR* and *IX* drop in lines and generating apparatus increase directly as the reciprocal of the power-factor, while the component of the *IR* drop in time-phase with terminal e.m.f. at the end of the line remains practically constant, and the component of the *IX* drop in time-phase with terminal e.m.f. increases directly as the sine of the angle of lag.

Moreover, the I^2R losses in the line and all parts of the circuit carrying the line current increase directly as the square of the reciprocal of the power-factor. Hence, if the line and other apparatus carrying the line current are so designed as to give the same *IR* drop when transmitting energy at a constant rate at any power-factor, the weight of copper must be increased directly as the reciprocal of the power-factor; or, if the line is designed for a constant I^2R or power loss in the line and other apparatus, the sectional area or weight of copper must be increased directly as the square of the reciprocal of the power-factor, or the diameter of circular conductors must be increased directly as the reciprocal of the power-factor.

Furthermore, the field excitation and consequently the voltage regulation of generating apparatus will be greatly increased when the current lags behind the e.m.f., the rate of increase being very rapid for the first 10 per cent decrease in the power-factor below unity, after which the rate of increase becomes approximately equal to the rate of decrease in the power-factor. This relation will be shown more clearly later on.

Finally, it may be said that when the power-factor is lowered, the wear and tear on switching apparatus will be greatly increased, due not only to the increase in the volume of current, but to the nature of the arc produced by the opening of an inductive circuit.

Fig. 2 shows the extent to which the excitation current of an induction motor causes the total current taken by the machine to lag behind the impressed e.m.f. *A B* is the magnetizing component of the current, required for maintaining the flux in the iron core and air-gap, which lags 90 electrical time-degrees behind the impressed e.m.f. *C B* represents the component of current in time-phase with the e.m.f. consumed in the internal losses of the motor. *A C* is the power component of the current which appears as useful mechanical power at the shaft. *A O* represents the total current taken by the motor, which lags behind the terminal e.m.f. by the time-angle Θ. It is apparent from the figure that if it is to be small and cos Θ, or the power-factor, high, the motors should be so built as to require a minimum amount of exciting current. It is also readily seen that if the motor is underloaded and takes power current equal to *D B*, the power-factor will be reduced to cos Θ_1. Hence, it is seen that for maximum power factors an induction motor should be designed for a minimum exciting current, and should be run at tne full rated load or above rather than below.

The action of a stationary transformer is similar to that of an induction motor except that it has no air-gap in its magnetic circuit; hence, its inherent magnetizing current for magnetic densities equal to those of the induction motor are a great deal less.

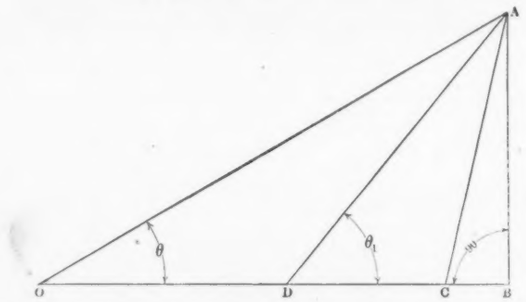


FIG. 2.—DIAGRAM SHOWING THE MAGNETIZING COMPONENT AND THE TOTAL CURRENT OF AN INDUCTION MOTOR.

Fig. 3, which shows the time-phase relations existing between the waves, which represent the instantaneous cyclic values of the e.m.f., and the corresponding values of the components of the current, is drawn to illustrate how the leading current taken by a synchronous motor may neutralize an equal amount of lagging current taken by other apparatus. *X*, *Y* and *Z* represent the central conductors of the stationary armature winding. Only one phase of the winding is shown in the figure for the sake of simplicity; the results, however, would be the same for any number of phases. The poles of the revolving field core are shown directly under the conductors or in the position where

the maximum value of the e.m.f. and the power component of the current occur. The light, full-line curve A represents the terminal voltage of the generator, the impressed voltage at the motor terminals and the power component of the current in the generator and the external circuit. The light dotted line curve B represents the lagging component of the current in the feeder circuit and also that in the generator and transmission line when the synchronous motor is not taking any leading current. The heavy full line curve C represents the total current in the feeder circuit and also that in the generator and transmission

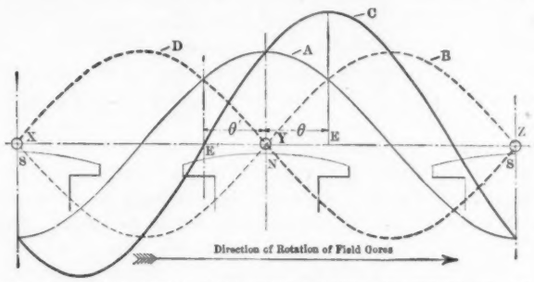


FIG. 3.—MECHANICAL AND TIME-PHASE RELATIONS IN AN ARMATURE.

line when the motor is not taking any leading current; its instantaneous values are equal to the sum of the instantaneous values of the curves A and B. The heavy dotted curve D represents the leading component of the current taken by the synchronous motor.

It should be noted that the leading current supplied to the motor by the generator is 180 electrical time-degrees ahead of the lagging current B supplied by the generator to inductive apparatus, which means that these two components of wattless currents have opposite directions with the result that the smaller component is completely neutralized by an equal quantity of the larger component; hence, the actual wattless lagging or leading current in the generator and transmission line up to the terminals of the motor will be equal to the difference between the values of these separate components. In Fig. 3 the lagging component is equal to the power component; thus the total current C in the feeder circuit beyond the terminals of the synchronous "condenser" lags 45 time-degrees behind the e.m.f., or there is a power-factor of 70.7 per cent in this part of the circuit. The leading component is also equal to the lagging component, which results in unity power-factor in the generator and line up to the terminals of the motor, there being no wattless components in this part of the circuit.

It should be noted that the ordinates of the curve in Fig. 3 representing the total current in the generator and line up to the terminals of the motor are equal to the algebraic sum of the ordinates of the curves A, B and D, representing the power, lagging and leading components, respectively, of the current supplied by the generator.

In connection with Fig. 3 it can readily be shown that lagging current in a generator and leading current in a motor demagnetizes the field magnets or poles, while leading current in a generator and lagging current in a motor magnetizes them.

When a generator is carrying a current A in time-phase with the terminal e.m.f. A the centers of the poles will be directly under the central conductors of one phase when the current in that phase has its maximum value; hence, the m.m.f. set up by the armature current is displaced by 90 time-degrees from the m.m.f. due the field winding, or is 90 electrical space-degrees behind that of the main field coils and exerts a cross magnetizing or distorting effect upon the flux set up by the main field. It is apparent that as the current begins to lag in time behind the e.m.f. or m.m.f. due to the main field, that the m.m.f. due to this lagging current will begin to oppose and neutralize a part of that due to the field current. In the diagram the center of the north pole is advanced to the position E (all other poles are advanced an equal distance) when the current C in the conductors X, Y and Z reaches its maximum value. With the field cores in this position with respect to the armature conductors when they are carrying their maximum current, it is easy to see that there is a large component of the m.m.f. due to the armature current opposing that due to the field current. If the current leads the e.m.f. in a generator, the field poles will have dropped back to a position E' when the current which leads the e.m.f. by the angle Θ' reaches its maximum value. It is readily seen that the m.m.f. due to the armature current will act with, instead of against, that of the field, thereby increasing the magnetic flux for a given value of the field current.

In applying this diagram to a motor it is to be noted if A represents the e.m.f. impressed on its terminals, and also the power component of current in its armature, with the polarity of the field cores as indicated in the diagram, then the direction of rotation will be from right to left, or opposite to that indicated by the arrow. With the direction of rotation reversed, the curve C representing the total current in the motor armature will be leading the impressed e.m.f. A instead of lagging behind the terminal e.m.f. A of the generator. The direction of rotation being reversed in this case changes the direction in which electrical time-degrees are to be measured; hence, it is seen that the field poles have the same mechanical position with respect to the armature conductors when the machine is operating as a generator delivering the lagging current C, that they have when it is operating as a motor taking the leading current C (at the same power factor) which results in both cases in an equal amount of demagnetization of the field when the armature ampere-turns are equal in the two cases. Moreover, the field poles have the same mechanical position with respect to the armature conductors when the machine is operating as a generator delivering a leading current C (not shown in the figure) that they have when it is operating as a motor taking a lagging current C at the same power factor; thus in both cases there is an equal amount of magnetization of the field.

It may be well to point out briefly the inherent characteristics of a synchronous motor which cause it to take current from the line, which may have any phase relation with respect to the impressed e.m.f. depending only upon the mechanical load and the strength of the field excitation of the motor.

Fig. 4 is a vector diagram drawn to show the time-phase relations which exist between the current, impressed e.m.f., counter e.m.f. and the e.m.f. consumed by the impedance of the armature winding. The base line $O\,A$ is drawn to represent the impressed e.m.f. at the motor terminals, which is to be kept constant for clearness in discussion. This line also represents to another scale the field ampere-turns required to give a generator e.m.f. on open circuit equal to the impressed voltage. The

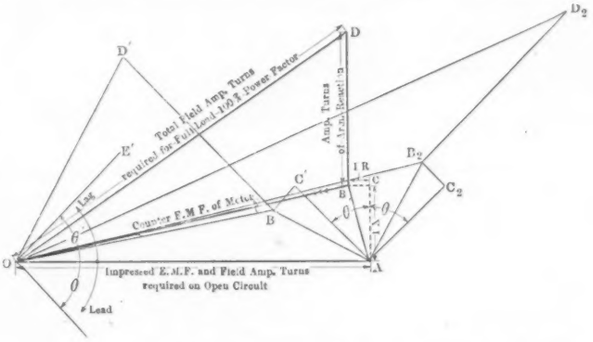


FIG. 4.—VECTOR DIAGRAM OF CURRENTS AND E.M.F. OF A SYNCHRONOUS MOTOR.

lines $O\,E$ and $O\,E'$ represent by their direction the time-phase relation of the armature current with respect to the impressed e.m.f., $O\,A$. The line $O\,E$ coincides with $O\,A$ when the current is in time-phase with the impressed e.m.f. Counter clockwise rotation of the line $O\,E$ indicates lagging current, while clockwise rotation indicates leading current.

The line $A\,C$ represents the reactance drop or the counter e.m.f. produced in the armature winding due to the local magnetic flux set up by the alternating current through the winding. The value of this reactance voltage depends upon the rate

of change of the local flux surrounding the armature conductor; in other words, it will have its maximum value when the rate of change of current is a maximum or when it is passing through zero, which means that the reactance drop leads the IR drop by 90 time-degrees and lags 90 time-degrees behind the impressed e.m.f., since the IR drop lags 180 time-degrees behind the latter. The line AC will, therefore, always be at right angles to the line OE representing the current.

Throughout this treatment the reactance will be considered to have a constant value, the frequency and speed remaining constant, hence the reactance drop will be proportional to the value of the current. This assumption is not far from correct for polyphase machines having smooth-core rotors, but is liable to vary greatly for different power factors in the case of single-phase machines having definite poles, due to the fact that the reluctance of the path of the leakage lines is much lower for low power factors because the pole shoes are located under the conductor when the current is passing through zero so that there is a high rate of change of leakage flux with a correspondingly high reactance voltage.

The line BC represents the IR drop, or the e.m.f. consumed in resistance, and is drawn parallel to the current line OE; it is directly opposed to the impressed e.m.f. or lags 180 time-degrees behind it when the current is in phase with the impressed e.m.f.

Consider, first, the case when the motor is delivering its

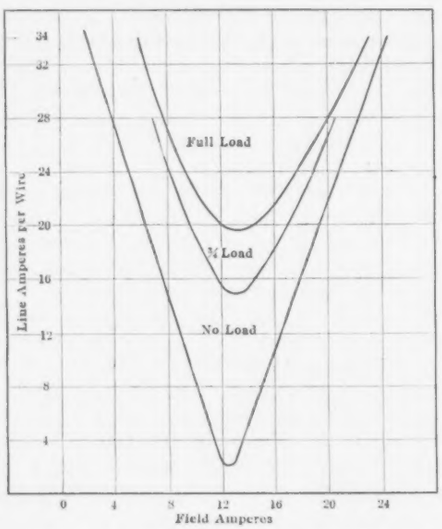


FIG. 5.—CURRENT CHARACTERISTICS OF A SYNCHRONOUS MOTOR.

normal rated load, the field excitation being adjusted so that the current taken by the motor is in time-phase with the e.m.f. impressed at its terminals. The diagram $OACBD$, Fig. 4, represents the relations of the various factors. The line CB will represent the counter e.m.f. developed by the motor, and its value will depend upon the value of the e.m.f. AB required to force the current through the armature impedance. The line OD, which represents the total ampere-turns of field excitation required, is obtained by combining the synchronous impedance ampere-turns $DB+CA$ with the ampere-turns corresponding to the impressed voltage minus the IR drop.

It should be noted that the line BD (drawn to the same scale as OA for ampere-turns) represents the field circuit ampere turns necessary to overcome the m.m.f. due to pure armature reaction, while CA represents to the same scale the field circuit ampere-turns necessary to force the current through the armature against the counter e.m.f. of self-induction.

It is of interest to note that an inductive circuit may be regarded as having "magnetic inertia" which causes the current to lag 90 time-degrees behind the impressed e.m.f.; the reactance of an inductive circuit is considered positive. The condenser circuit may be regarded as having a "magnetic vacuum" into which the current rushes 90 time-degrees ahead of the impressed e.m.f.; the reactance of a condenser is considered negative.

The armature reaction of a synchronous motor combines with the local magnetic leakage reactance to produce what is commonly called the "synchronous reactance"; the component of the latter, which is due to the armature reaction, is of interest in the part it plays in causing the current which gives rise to it to lag behind or lead the impressed e.m.f. The over-excited synchronous motor possesses a certain amount of inductive or positive reactance due to the current through the inductive circuit; it also possesses a certain amount of negative reactance due to the over excitation of the field, which creates, as it were, a magnetic vacuum, with respect to that part of the synchronous reactance which depends upon the armature reaction, into which the current rushes ahead of the impressed e.m.f., thus supplying the m.m.f. necessary to neutralize the excess m.m.f. on the field core over and above that required at unity power factor.

Suppose the field excitation be increased to some value OD_2 (Fig. 4), the load, impressed e.m.f. and speed remaining constant. The counter e.m.f. will be increased in proportion to the increase in the number of lines of force which cross the air-gap from the field poles and become linked with the armature conductors, the actual increase in voltage for a certain increase in field current depending, of course, upon the saturation of the magnetic circuit.

The diagram $OAC_2B_2D_2$ of Fig. 4 represents the relations which will exist when the fields are over excited. The increase in the field m.m.f. and flux above that required for maintaining the counter e.m.f. at the value OB tends to set up a flux through the armature in a direction which opposes the m.m.f. or flux due to the armature current, or tends to set up a "magnetic vacuum" with respect to that part of the synchronous reactance due to armature reaction. The result is that the current rushes in ahead of the e.m.f. and sets up an armature reaction which results in equilibrium as indicated in the diagram $OAC_2B_2D_2$, Fig 4. The armature current will increase, because the load remains constant and the power factor is decreasing until the current and power factor have such values as will produce a demagnetizing component of armature reaction sufficient to reduce the field flux to a value which will cause to be generated a counter e.m.f. which combined with the impressed e.m.f. will produce a resultant e.m.f. AB_2 large enough to force the current through the impedance of the armature winding.

If the field excitation is decreased to some value OD^1, the counter e.m.f. will be decreased to the value OB^1 which combined with the impressed e.m.f. will produce a resultant e.m.f. AB^1 large enough to force the current through the impedance. In this case the armature current will lag behind the impressed e.m.f. and will increase to such a value as will produce a magnetizing component of armature reaction sufficient to maintain the field flux at the value required by the counter e.m.f. OB^1.

The "phase characteristic" curves, shown in Fig. 5, are added to show how the armature current varies with a change in the field excitation, the mechanical load on the motor remaining constant in each case. The no-load curve is that taken with the motor running light. When there is no field current on the motor the machine runs like an induction motor, taking a large lagging current which supplies the magnetic flux required by the impressed e.m.f. When the field current is gradually increased in value from zero the armature current decreases while the power factor increases until the armature current is in time-phase with the impressed e.m.f., at which point the m.m.f. of the field current is just sufficient to maintain the magnetic flux at the value demanded by the e.m.f. impressed upon the motor. The minimum input when the current is in time-phase with the e.m.f. represents the power loss in the motor; that is, core loss, friction and windage and a small amount of I^2R loss in the armature. If now the field current is further increased the motor will take from the line an increasing current which leads the e.m.f., as is done in the case of synchronous motors running light as a "rotary condenser." The mechanical load on the motor can be increased to obtain any number of similar curves, two of which are shown for three-quarter and full-load, respectively.

Electrical Improvements at Elmira, N. Y.

The Elmira Water, Light & Railroad Company controls all the public utilities in Elmira, N. Y. These consist of the water, gas, natural gas, electric light and street railway systems. The railway and electric light systems are fed from a central power station situated about 3000 ft. from the center of load convenient to the Lackawanna and Erie railroads, over which the coal is brought. Artificial gas is made in a gas station adjacent

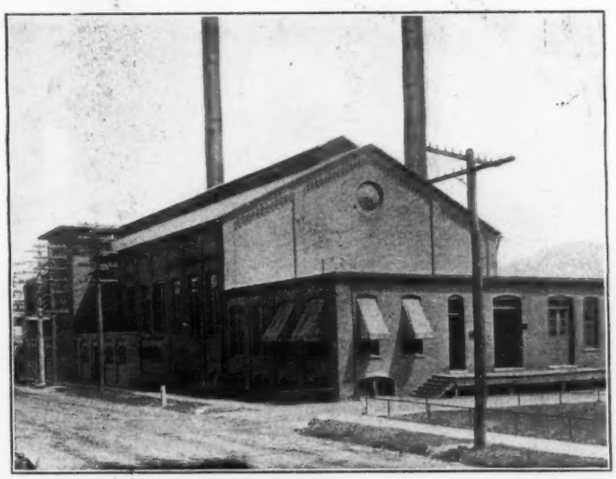


FIG. 1.—EXTERIOR OF POWER HOUSE.

to the electric generating station. This is sold at a rate of $1.10 per thousand cubic feet. Natural gas is brought from Olean, N. Y., under pressure and is distributed direct from the mains without any intermediate receivers. The price of natural gas is 35 cents per thousand cubic feet.

The rates for electrical energy for house lighting are based on the demand, although there is an open schedule rate of 15 cents per kw-hour less a discount of 10 per cent for payment within 10 days. With the regular rate the consumer guarantees

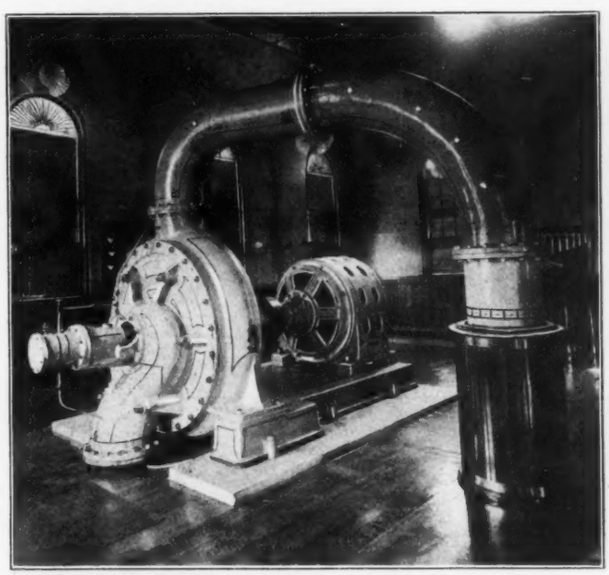


FIG. 2.—TURBINE PUMP FURNISHING RAW WATER TO FILTER.

the use of 1 kw per month per room wired. This consumption is guaranteed for the purpose of reimbursing the company for its readiness to serve and is billed at 15 cents per kw-hour. All energy consumed above this guaranteed amount is billed at a follow-on rate of 7½ cents per kw-hour. The total bill is discounted 10 per cent if payment is made before the 10th of the following month. The minimum charge under this rate is 75 cents per month. For store lighting under the regular rate, the consumer guarantees the use of 2 kw per month per 16-cp lamp or its equivalent. The guaranteed consumption is billed at the rate of 10 cents per kw-hour and all additional energy is billed at the rate of 6 cents per kw-hour. A discount of 10 per cent is allowed for prompt payment and the minimum bill is $1 per month. The open schedule rate for store lighting is 10 cents per kw-hour subject to the regular discount for prompt payment.

The regular rate for motors is based on a guarantee by the consumer to the company for readiness to serve. On this basis the consumer pays $1 per month per horse-power installed and nothing less than 1 hp is considered. On all motors up to 5 hp the rate for energy in addition to the readiness to serve rate is 4 cents per kw-hour for the first 100 kw-hours per horse-power and 3 cents for all energy above this amount. For motors from 5 hp to 10 hp the rate is 3 cents per kw-hour for the first 100 kw-hours per horse-power, then 2 cents per kw-hour for all additional energy plus the usual service charge. For motors above 10 hp rating the rate charged is 2½ cents

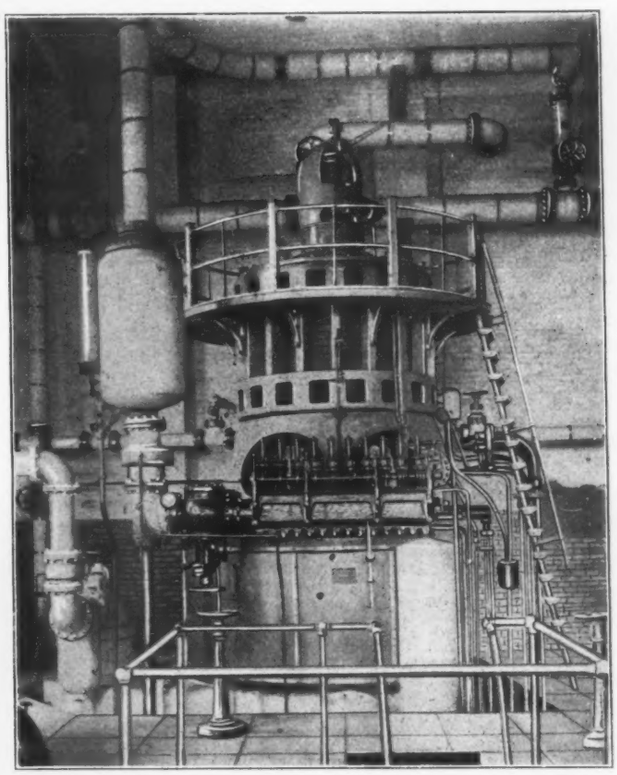


FIG. 3.—2250-KW CURTIS TURBINE.

per kw-hour for the first 50 kw-hours per horse-power, and 2 cents per kw-hour for all additional energy plus the usual standby charge and minus the usual cash discount. The open schedule for motor service is 10 cents per kw-hour less the discount for prompt payment.

GENERATING STATION EQUIPMENT.

Since the first of the year the company has installed a 2250-kw, three-phase, 60-cycle, 2300-volt Curtis turbine unit shown in Fig. 3 herewith. This unit runs condensing, the water for the purpose being obtained from wells located about one-half mile from the generating station. Surface condensers are used, since the cooling water cannot be used for boiler feed water purposes because of the magnesia contained in it. In addition there is a 750-kw, 2300-volt, three-phase unit driven by a horizontal cross-compound engine; one 400-kw unit driven by a vertical cross-compound engine; two 350-hp engines driving four 100-light arc machines and one 250-kw, 500-volt generator to be taken out shortly and disposed of. The arc circuits have

been changed over from direct-current lamps to alternating-current, enclosed type lamps requiring 7.5 amp. There is a 500-kw, direct-current unit driven by a Fitchburg engine and two 200-kw units belted to a McIntosh & Seymour engine. Motor circuits are fed from a 300-kw rotary giving 500 volts on the three-wire system and a 750-rotary converter feeds the railway load. Two exciter sets are provided, each rated at 50 kw. One is motor-driven and the other is steam-driven.

In connection with the generating equipment a Gould battery has been installed having a capacity of 560 amp for one hour or 1680 amp momentarily. The booster is made up of an induction motor requiring current at 365 volts and a separately-excited generator wound for 140 volts and capable of carrying 600 amp continuously and 1700 amp momentarily. The regulating outfit controls the battery charge and discharge so that the component of the alternating-current generator load to be regulated by the battery will not vary more than 7½ per cent plus or minus from the desired average as long as the battery current required does not exceed the battery charge and discharge current capacities, and so long as the booster voltage required is not in excess of the booster voltage capacity. The average value of the component of the generator load to be regulated can be adjusted over a wide range. A load limit device is installed and connected so as to permit the regulation to be obtained so long as the battery charge and discharge currents are not in excess of the battery charge and discharge capacities, etc. Upon a tendency for these capacities to be exceeded the load limit device modifies the booster excitation so as to keep the currents and voltage within safe limits. It will

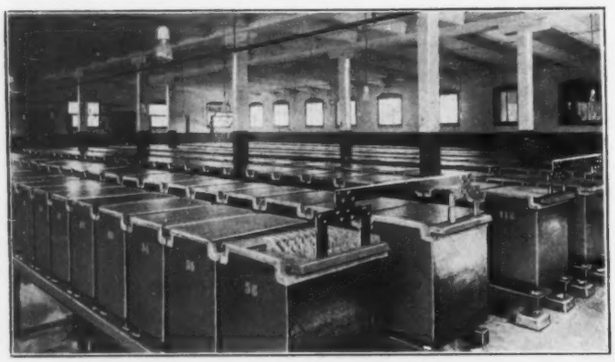


FIG. 4.—STORAGE BATTERY ROOM.

be understood that the battery is regulated from the alternating-current side from the turbine unit according to the fluctuations in voltage.

The steady load on the fire-room equipment is carried by 1600 hp in boilers fitted with Roney stokers. These are kept constantly under steam and the variable load at peaks is taken by hand-fired boilers. The fuel used is bituminous run-of-mine, costing from $2.25 to $2.30 per ton delivered. In this way steam economy and low cost of operation are obtained. The railway and lighting load overlap at night and the hand-fired boilers carry the peak. The switchboard in the generating station has been rearranged to take care of the new apparatus and new panels have been added.

PUMPING STATIONS.

Inasmuch as the company owns the water works, it has found it to its advantage to equip the pumps with electric motors of the induction type. This not only has resulted in a great saving in the cost of pumping water, but has also helped the load factor on the generating station, as the pumps in the water and filter plant are not operated at the peak, but when the load is light. As a result the load factor on the station is 52. There is an 8,000,000 gal. turbine in the pumping plant which is driven by a three-phase induction motor, shown in Fig. 6. The water is forced to the filter plant and from there a 1,000,000-gal. motor-driven pump forces it to the reservoir, whence it flows by gravity to the consumers.

NEW BUSINESS METHODS.

The company has just started on a systematic campaign for new business, especially for day load. A very low rate is given for load factors of 60 or more. The company's solicitors for

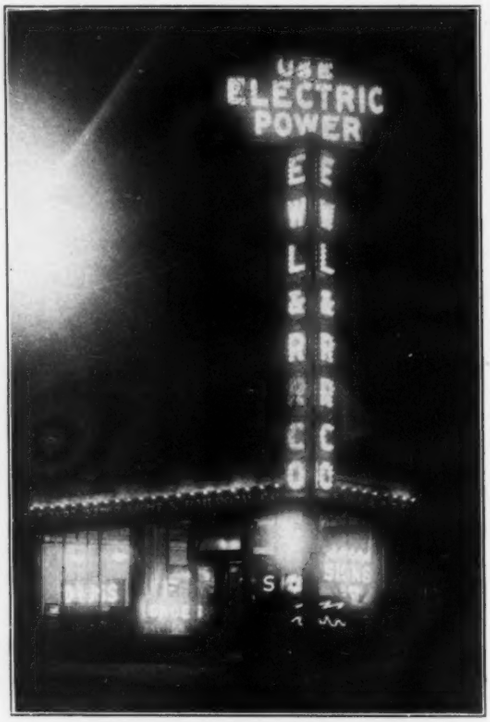


FIG. 5.—GENERAL OFFICES.

motor load visit factories and make tests to determine the load and losses due to the system in use. They acquaint the owner with the cost per horse-power per connected load as determined by them and state for what price the company will undertake to furnish energy to operate the equipment. Attention is also

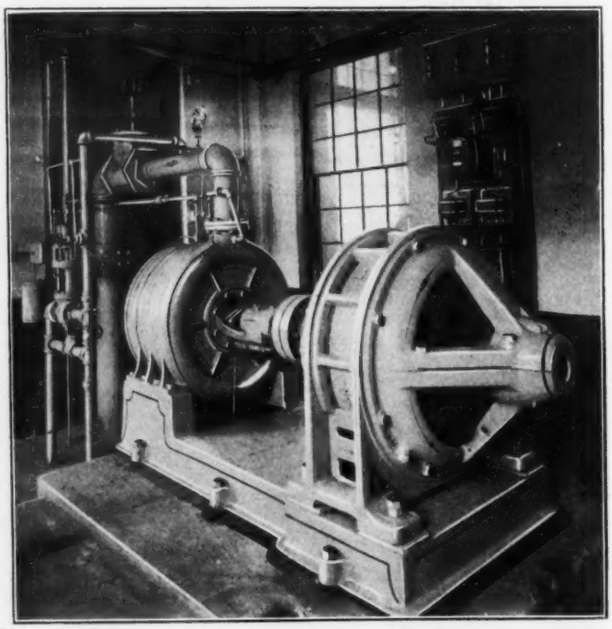


FIG. 6.—TURBINE PUMP SUPPLYING HIGH PRESSURE SYSTEM.

directed to the fact that the efficiency of the operator is also increased about 10 per cent, a fact often lost sight of. The company is fast getting rid of its 500-volt, direct-current power

service and all new business is being connected to alternating-current circuits.

By means of a close alliance between the contractors and the commercial men, the contractors consult with the company before getting service. As a result the company is not hampered with unsatisfactory work on the part of the contractor, the unsatisfactory operation of which might afterward be attributed to the company's service. A campaign has also been made on flat-irons and signs. A little over three months ago there was not an electric sign in Elmira, now there are over 22. The signs are sold outright at cost and are connected to metered circuits. Three hundred flat-irons were put out recently on trial and only 60 were returned. The company is aiming to get a good and permanent commercial force which will not only look after new business but keep in touch with old business. The solicitors visit old customers to ascertain facts about the service. In this way the conditions of the service are known at first hand and are reported to the superintendent of the electric light plant. In this way mistakes in circuits and service are corrected and the customer is better satisfied. The solicitor advises customers about lamps and illumination in general, and inasmuch as the company renews lamps free of charge, the customer is often impressed with the fact that the unsatisfactory lighting equipment is oftentimes due to his neglect to renew the old lamps. The same is true of arc lamps in stores. Oftentimes these are not properly trimmed and the solicitor on his visits sees that such defects are rectified.

The general manager, Mr. Cole, who has just severed his connection with the company, has impressed upon the soliciting force that its work does not end, but has only commenced when a customer is secured. The solicitors at Elmira have been educated to feel that the electric light company has nothing to conceal, that there is nothing mysterious in the production of electricity, that when properly installed electric lighting is not only desirable, but is a great improvement over other lighting systems. In the spring attention is concentrated on the flat-iron; in the summer on electric fans and in the fall on signs; motor business being solicited at all times. Owing to Mr. Cole's energetic and honest conduct of the business, which, as pointed out, embraces all the public utilities in Elmira, criticism of the company is almost unknown, the various conflicting interests have been harmonized and the company has reaped its reward financially.

Improvements in Unipolar Generators.

A simple form of direct-current generator of the homopolar or acyclic type is shown in Fig. 1, which represents a machine patented by Mr. J. E. Noeggerath on Aug. 11. The machine is intended for low voltage and possesses only one armature conductor, which is the armature core itself. The current is collected from the shaft as one terminal, the other terminal being formed by collector rings, which serve also to strengthen a shell which holds the magnetizing windings in place. The terminal brushes are represented at *B* and *B'*. The generator illustrated is arranged for separate excitation, two small collector rings serving for connecting the magnetizing winding to the source of excitation.

Except in low-voltage machines, the armatures of unipolar generators are provided with a plurality of conductors and collector rings, through which the armature conductors are connected in series by means of stationary cross-connecting conductors and brushes bearing on the collector rings. Mr. Noeggerath also obtained a patent on Aug. 11 for a method for rendering the cross-connecting conductors readily accessible. These conductors are mounted on plates detachably secured to the field structure, so that they are bodily removable as a unit with the plate. Moreover, the brushes are mounted directly on the cross-connecting conductors so that the brushes are also removable with the plate for inspection and renewal.

The arrangement proposed by Mr. Noeggerath is shown in Figs. 2 and 3. The cross-connecting conductors are formed of flat insulated strips secured to the detachable plate by clamps. Leads are connected to the central points of the conductors so that a plurality of different e.m.fs. may be derived from the machine. Mounted directly on the ends of the cross-connecting conductors are the brushes *G*, which are formed of superposed flexible metallic strips, since this type of brush is most satisfactory for collecting current at high speed. Idle lubricating brushes, *I*, formed of graphite, also bear on the collector rings, and while performing no electrical function, serve to lubricate the rings and decrease the wear on the current collecting rings and brushes.

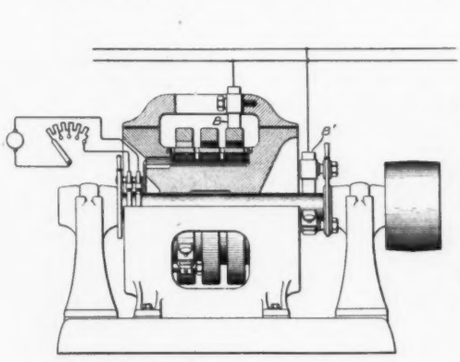
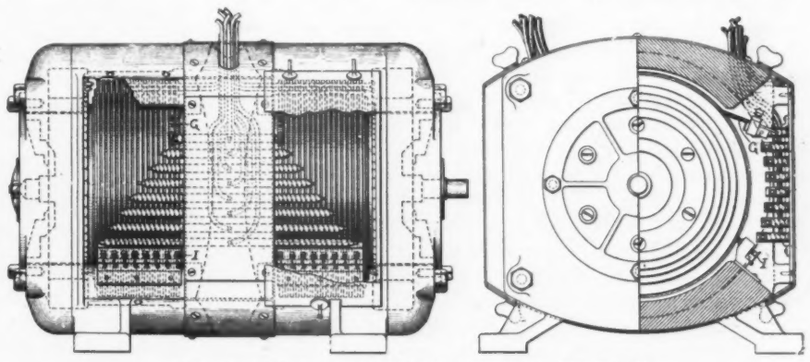


FIG. 1.—NOEGGERATH UNIPOLAR GENERATOR.



FIGS. 2 AND 3.—NOEGGERATH UNIPOLAR GENERATOR.

The Resistance of Lightning Arrester Earth Connections.

BY E. E. F. CREIGHTON.

A knowledge of the value of the resistance of the earth connection becomes important with lightning arresters used on grounded neutral of a transmission system, with the overhead grounded wire, and in the maintenance of the foundations of iron towers for transmission lines. These various factors will be reviewed in the present article.

Why the knowledge is important is almost evident. If there is a high resistance between the earth connection of a lightning arrester and the apparatus, the limitation of the potential to a safe value across the arrester will be of no avail in protecting the apparatus. The real object to be attained is not, however, to have a low resistance of earth connection but to prevent any sudden or dangerous differences of potential within the station.

When the neutral of a three-phase system is not grounded it is possible to increase the potential above the earth of two of the wires to full line potential (1.73 times the Y-potential) by connecting the third wire to ground. In the practice of lightning protection this condition is taken care of by the use of the multiplex connection which gives the same length of path through the arrester from line to line as from line to ground. This arrangement involves a fourth, or ground, leg in the arrester. When, however, the neutral of the system is thoroughly grounded, the three phases may be considered independent so far as concerns this factor in the application of the

arrester. The ground leg of the arrester may be omitted. Grounding a wire accidentally in this case produces a short-circuit of one phase which should cause the circuit-breaker to trip.

The current trouble, it may be remarked in passing, is not the only source of danger; the heavy current in one phase of a generator will react on its field magnets and will thereby cause a momentary increase of potential in the other two phases which often reaches dangerous values. It is extremely difficult to discharge this form of disturbance because the abnormal potential has back of it not only the stored energy of the line but, which is far greater, the total power of the generator units. During

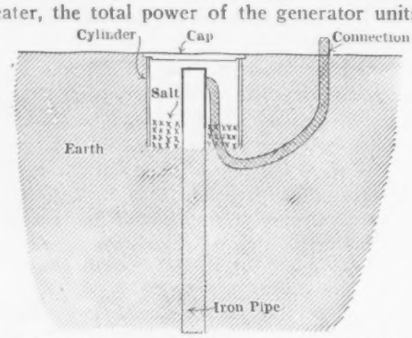


FIG. 1.—RECOMMENDED FORM OF PIPE EARTH CONNECTIONS.

short circuits of one phase of a modern generator of good regulation the enormous mechanical strains have twisted the main shafts and have bent armature and transformer coils out of shape. The foregoing facts are some of the factors which have led to the use of resistance in the neutral. If the system is three-wire and the neutral is earthed there is an additional earth contact resistance involved. So far as lightning protection is concerned, such a system can no longer be considered as possessing a grounded neutral; an arrester for non-grounded neutral must be used.

Even when a system has a low resistance in the neutral connection to earth, it is possible for the resistance either to increase or decrease under the heating action of the generator current when a wire is accidentally grounded. If conduction is by moisture, the moisture may be quickly dried out and the resistance increased thereby a million fold. If the heat becomes intense the resistance may drop to practically zero by pyro-conduction. Such a condition exists in cement and graphite clay compounds. Cement resistors are discussed later.

In grounding the overhead protective wire, the cost enters as an important factor. To be effective against direct stroke of lightning the earth connections should be placed at frequent intervals. Each earth connection should have a reasonably low resistance, sufficient endurance to discharge a heavy stroke without undue increase in resistance, and a quick and sure recovery of conductance. How these factors are to be obtained is shown later. It seems that one salted pipe-earth connection at each point of the overhead wire that is earthed should be sufficient.

In the erection of steel towers for transmission lines the foundations are sometimes made of cement or concrete. If the system has a grounded neutral and a wire becomes accidentally connected to a tower, the heat generated in the foundations by the passage of energy from one phase through them may be sufficient to disintegrate the concrete.

STUDY OF EARTH CONNECTIONS.

For many years the standard recommendation for making connections to earth has been: (1) bury a slab of copper about 2 ft. sq. in a considerable amount of coke, (2) connect a wire to the water mains, and (3) locate a copper plate in the mud of a body of water.

The first involves a large expense in installation, is concentrated at one point, and has an unknown value of resistance which may vary greatly with a change in moisture. The second gives a low value of resistance as a rule, but is not available on lines and in many substations. The third may give a low-resistance connection to earth, but usually requires an objectionably long connecting wire.

With the object of learning the effect of distance between adjacent earth connections on the resistance, effect of the size of the earth plate, depth of conducting stratum and the most economical method of reaching it and maintaining contact, the writer made a series of tests, several of which are reported below. Some of these tests were begun in 1906 and continued until the present.

METHODS.

In making the measurements an e.m.f. of 110 volts alternating was used. A 150-volt meter, one 1.5-amp meter and one 15-amp meter were used. These tests have shown that a good method of making an earth connection is to drive a number of iron pipes vertically into the earth spaced six or more feet apart, all being connected together. Each pipe should have the earth cupped out around the surface, salt placed therein and a certain amount of water added to cause the salt to percolate through the earth in the neighborhood of the pipe. Such an earth connection is shown in Fig. 1. Under the usual conditions these pipes may be driven from 5 to 8 ft. deep. The average earth-contact resistance of one of these pipes in soft earth will be about 15 ohms. In very gravelly soil the resistance will run somewhat higher. In good loam soil the resistance may be lower.

LAWS OF THE RESISTANCE OF EARTH CONNECTIONS.

The resistance of one of these pipe earth connections depends upon the following factors: (1) the depth to which the pipe is driven; (2) its distance from the other connected electrodes; (3) relative shape and position of electrode; (4) the specific conductivity of the earth in the near neighborhood of the pipe and its maintenance.

Fig. 2 shows the variation in resistance of five different pipes at every foot penetration into the earth. Some of these pipes were on high, dry ground and others were on low, damp ground,

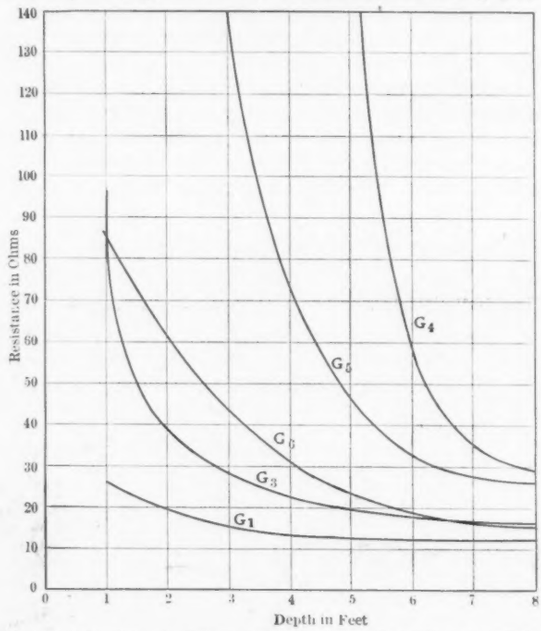


FIG. 2.—VARIATION OF EARTH CONTACT RESISTANCE AT DIFFERENT DEPTHS OF DRIVING PIPES.

but it should be noted that all of them at about 6 ft. depth had resistances which were not widely different. After the pipe strikes the conducting stratum the resistance can be lowered very little by driving the pipe to a greater depth. When just touching the surface of the earth, the resistance of a number of pipe earths varied between 1000 and 10,000 ohms, according to the location.

VARIATION IN RESISTANCE AT DIFFERENT DISTANCES APART OF THE ELECTRODES.

If several pipes are driven in homogeneous soil at different distances apart, it is found that the resistance between pipes increases as the distance between pipes increases up only to about

6 ft. distance. For greater distances the resistance is practically constant independent of the distance between the pipes.

RELATIVE SHAPE AND POSITION OF ELECTRODES.

Calculations from a number of tests show that the current flowing into an earth pipe or multiple earth pipes follows the same general logarithmic laws as the displacement, or condenser charging current, in a transmission line. For example, if the charging current of a single overhead conductor to earth is measured and then a second conductor is hung by its side, or another conductor of double its area is used, it will be found that the charging current is practically the same. This result may be derived from the standard tables of capacity of overhead wires.

If the second conductor had been hung at a distance of several feet from the first conductor, the condenser charging current of the two would have been approximately double that of one. Applying this analogy to the resistance of the earth it is found that if two pipes are driven side by side the resistance of either one to a distant earth connection is the same as both connected in parallel. In other words, if the resistance of one to a main pipe-line earth connection is 15 ohms the resistance of the two in parallel will be about 15 ohms. This is due to the fact that one is driven into the dense current lines of the other and consequently can add nothing to the distribution of the current over a large cross-sectional area of the earth. In order then to decrease the resistance of pipe earth connection by multiple arrangement, it is necessary to space the pipes 6 ft. or more apart. With this distance apart the total resistance of a number of pipes in multiple connection will decrease almost in proportion to the number of pipes.

In general, it may be stated that most of the resistance between two pipe earth connections resides in the immediate vicinity of the pipes. Here the current is densest, or, in other words, the cross-section is least. After the current stream lines once spread out, the greater cross-section of the earth makes up for its low specific conductivity.

Since driving a pipe beside another and connecting the two in parallel does not materially lower the resistance, it is evident that increasing the diameter of the pipe causes very little decrease in the resistance. A rod or pipe just large enough to give mechanical strength is sufficient for all practical needs. One-in. pipes are suitable, and rods of small diameter are better for stony ground.

SPECIFIC CONDUCTIVITY.

Since the resistance resides mostly in the neighborhood of the pipe, and the conductivity is due entirely to the moisture, the conductance may be greatly increased by adding a good electrolyte, like a salt solution. Salt not only increases the conductivity, but maintains it by attracting and holding moisture. Even if the pipe does not penetrate the conducting stratum of earth, the salt water will do so, as a rule, and thus establish a good connection.

The maintenance of the conductivity of the earth immediately around the pipe is jeopardized when heavy generator current is caused to pass to ground. This occurs especially on a grounded-neutral system. The energy thus lost evaporates and drives away the moisture immediately around the pipe. As an example, a non-salted earth pipe carried 20 amp (600 volts impressed) for three minutes, when the resistance increased and the current was reduced to 4 amp. When the ground around this pipe was salted, the pipe carried 32 amp for three minutes (600 volts impressed), the current decreased to 23 amp and remained constant for 75 minutes (28 times as long as under the non-salted condition). In each case the pipe earth connection recovered its full conductance after standing idle for about five minutes.

LIGHTNING CONDUCTORS.

The use of multiple pipe earth-connections modifies the practice of protecting buildings by lightning conductors. The liability of the lightning "side stroking" into the building and thus causing damage or danger to life will be greatly reduced by using the following method:

Make eight or more pipe earth-connections around the building and connect all of these together by a horizontal wire. From each pipe string a vertical wire to the eaves, and from the eaves the wires should be joined to the lightning rod or rods which project 6 ft. or more above the highest points of the building. These wires should be connected by a horizontal wire at about the level of the eaves. If several lightning rods are used they should also be connected together at the peak of the roof. The pipe earth-connections should be salted to give high conductivity. Where economy is necessary, galvanized-iron telegraph wires can be used. It is probable that the only difference between iron and copper wire under these conditions of installation will be in the less liability of corrosion and final destruction of the copper.

CEMENT AS A RESISTOR.

Some time ago the possibilities of trouble with lightning arresters on a system using cement resistors connected between the neutral of the system and ground suggested the necessity of studying the characteristics of cement. It has been noted already that arresters for non-grounded-neutral systems require an extra "leg" between the multiplex connection and earth to limit the generator potential across the arrester in case a wire becomes accidentally grounded. If the resistance in the neutral increases appreciably, the condition is equivalent to a non-grounded-neutral system.

Another important phase of the subject is related to the use of cement in poles and as anchors or foundations for electrical transmission towers. In the event of a shattered insulator, the cement or concrete will be called upon to carry either the charging current or the current of one phase according to the connections. In this case the question of conductivity is a minor matter and attention should be directed to the possibility of disintegrating the cement by overheating.

A set of tests carried out to determine the characteristics to apply to the foregoing problems, although not complete, seems to justify the following conclusions:

At moderate temperatures the resistances depend simply on the amount of moisture in the cement and become extremely high if the moisture is removed, either by long drying or artificial heating. The addition of sand increases the resistance, acting apparently as an insulator distributed throughout it. When the temperature of cement is raised by external heat it at first increases enormously in resistance as the moisture is driven off, but at red heat it again becomes as good a conductor as when cool and damp. With the same voltage per unit of length, a moderate e.m.f., such as 600 volts, will not increase the temperature of the material to above 100 deg. C., so as to pass the interval of high resistance; but a higher e.m.f., such as 8000 volts, can pass this interval and heat the resistance to incandescence.

SUMMARY.

The test made with cement rods having different proportions of sand show a progressive increase in resistance with increase in the amount of sand, leading to the conclusion that the sand acts practically as an insulator distributed through the cement, thereby diminishing the effective conducting cross-section of the rod.

All the experiments on the change in resistance with age or with heating indicate that at moderate temperatures the conductivity depends almost entirely on the amount of contained moisture. It would appear probable that the moisture dissolves a portion of the cement to form an electrolyte which, being diffused throughout the body of the cement, conducts the current, the solid part of the cement acting simply as a container for the electrolyte.

The experiments on resistance at high temperatures and at high voltages show that cement possesses, in addition to its low temperature or moisture conductivity, a high temperature or pyro-conductivity.

A high voltage dries the moisture out in spots, usually beginning near the metal terminal, and the insulating distance is bridged by an arc which heats the dried cement to redness and thus re-establishes the conductivity, which is then maintained by the passage of the current. The "arc spots" or streaks finally cover the distance between electrodes and establish a pyro-conducting streak.

A. I. E. E. Papers on Electric Railways.

SINGLE-PHASE EQUIPMENT OF A SINGLE-TRACK ROAD.

At the recent Atlantic City convention of the A. I. E. E. Prof. J. B. Whitehead presented a paper describing the Annapolis Short Line, a 25-mile road between Baltimore and Annapolis, Md., which is to be changed from steam to electric operation. The change will be made in order to obtain increased car-mileage, more frequent service and the cleaner and more attractive service inherent in electrical operation. The conditions, however, are not such as to offer any prospects of increased economy of operation by electricity; in fact, although the operating and maintenance expenses are estimated to be about equal for steam and for electricity, with interest charges included, the total of the items is found to be about 1.6 per cent greater for electricity than for steam. Detailed estimates given by the author seem to show that a high-voltage, single-phase system was preferable to a direct-current system. A 25-cycle, 6600-volt system has been selected, the energy being obtained from single-phase generators directly coupled to 25-cycle, three-phase, 13,000-volt, synchronous motors. The generating station is located 1.6 miles from Baltimore, while a substation has been erected 17.4 miles from the main station, or 6 miles from the Annapolis end of the line.

DISCUSSION.

Mr. W. L. Waters in discussing Prof. Whitehead's paper stated that the reliability of the single-phase railway equipment had been conclusively shown by the operation of the single-phase locomotives on the New York, New Haven & Hartford Railway where only four armatures, out of a total of 200 in use during the past year, have given serious trouble.

Mr. W. I. Slichter remarked that in determining the reactance of rails it is necessary to consider the probable variation in the permeability and the effect of a change in the shape of the rail on the flux produced by the current. Moreover, it is not proper to neglect the effect of the power factor of the current upon the voltage drop produced in the impedance of the rail.

Mr. William McClellan expressed the opinion that when isolated roads or isolated sections of a large railway system are being electrically equipped, due consideration should be given to the probable future extension of electrification to all railroads of the country.

In a written communication read by Mr. C. F. Scott, Mr. A. W. Copley reported the results of impedance tests made upon the circuits of the New York, New Haven & Hartford Railroad. The impedance of 100-lb. rails was found to consume 18.9 volts per mile when the rail carried 100 amperes at a frequency of 125 cycles; at 15 cycles the impedance drop for the same value of current was 13.0 volts. The tests indicated that the ratio of the impedance for 25-cycle current and the resistance for direct current in 100-lb. rails varied from 2.5-to-1, to 3-to-1.

LOCATION OF ELECTRIC RAILWAY SUBSTATIONS.

Mr. G. B. Werner presented a paper in which there was developed an equation for expressing the number of substations, or the distance between substations, that will render the total annual charges on the installation a minimum. The charges considered were those relating to the investment in substation apparatus, and overhead conducting material and the cost of losses in the substations and on the line. By expressing each of these four charges algebraically and determining the value for each which will render the sum a minimum, it was found that the cost of copper should be equal to that part of the cost of the substation which is independent of the output.

CONDUCTOR-RAIL MEASUREMENTS.

A report of tests made on the "third" and "fourth" rails of the Metropolitan District Railway and the Baker Street & Waterloo Railway, in London, was given in a paper by Mr. S. B. Fortenbaugh. In neither case was the running rails used for transmitting energy to the cars, because they were employed exclusively for track-circuit signal systems. Hence two separately-insulated conductor-rails were required for each single-track railway. The "third" and "fourth" rails are supported on brown stoneware insulators. During the tests the polarity of the two conductor-rails were reversed repeatedly. The tests showed that the difference of potential between the positive conductor and the earth is always normally considerably greater than the potential existing between the negative conductor and earth. The difference between the positive and the negative insulation becomes more marked the longer the conductors are subjected continuously to a difference of potential in the same direction. A reversal of the polarity is always instantly accompanied by a considerable increase in the normal leakage current between the positive and the negative conductor. It was concluded that it is more difficult to insulate a negative conductor than a positive conductor from the earth.

Engineering Features of the Southern Power Company's System.

In a paper read by Mr. J. W. Frasier at the Atlantic City convention of the A. I. E. E. the author explained the conditions relating to the sale of energy that had affected the design of the systems of the Southern Power Company. Descriptions of the systems were given in our issues for July 23, 1904; May 25, 1907, and Dec. 28, 1907. A frequency of 60 cycles was selected, largely on account of the existence of many 60-cycle machines and the extra cost of 25-cycle as compared with 60-cycle apparatus. It was considered that 44,000 volts was preferable to a higher value because the distance over which the energy is transmitted is relatively so limited that the saving in copper by increasing the e.m.f. would not offset the extra cost of the apparatus for the higher e.m.f. An e.m.f. of 2000 volts is considered standard for large mill motors; this e.m.f. permits all mills within a radius of two miles to receive energy from one substation.

Test of Gas-Electric Generating Station.

At the Atlantic City convention of the A. I. E. E. Mr. J. R. Bibbins reported the results of a 30-day test on the generating station equipment of the Richmond Works of the American Locomotive Company, of Richmond, Va. The equipment consists of a 23.5-in. x 33.0-in. horizontal, tandem gas engine with a direct-connected direct-current generator operating on producer gas obtained from a pair of 9-ft. (shells) bituminous producers. The generator supplies energy to motors and lamps in the locomotive shops, the load being fairly constant. The accompanying table records the general results of the test:

GENERAL RESULTS OF TEST.

Nominal load.	Full.	Three-quarters.	One-half.
Length of run, hours	223	125	136
Average load, kw	312.3	228.3	159.6
Average load, computed hp	455.0	333.0	238.0
Load, per cent engine rating	91.0	67.6	47.5
Load, per cent generator rating	104.0	77.2	53.2
Coal gasified, lb	115,289	54,143	47,775
Coal gasified, per hr	517.0	433.0	351.0
Output, kw-hr	69,650	28,540	21,710
Lb. coal per kw-hr	1.654	1.697	2.20
Lb. coal per kw-hr, guaranteed	1.93	2.10	2.64
Lb. coal per boiler hp-hr	1.14	1.31	1.56
Average heat value of coal, B.t.u.	14,392	14,392	14,392
B.t.u. per kw-hr	23,700	27,280	31,650
B.t.u. per boiler hp-hr	16,415	18,710	21,670
Per cent thermal efficiency, brake	15.51	13.6	11.75
Per cent thermal efficiency, elec.	14.35	12.65	10.78

Coal.—Pocahontas run-of-mine; avg. heat value dry sample, 14,703 B.t.u. per lb; as fired, 14,392; volatile matter, 22.8 per cent; ash, 4.5 per cent; sulphur, 1 per cent.

Test.—August 12, 7 a. m., to September 7, 12 m.

In comparing the cost of producing electrical energy in the above plant with an equivalent steam-turbine plant for the same duty, the author stated that at the price of coal prevailing in Richmond ($2.70 per ton) the gas plant shows a 13 per cent gain over steam at full load and 5 per cent at half load. The estimates include interest, etc., on the cost of the complete gas plant at $138 per kilowatt and of the steam plant at $100 per kilowatt.

DISCUSSION.

In discussing Mr. Bibbins' paper on gas engine-driven electric stations, Prof. J. P. Jackson expressed the opinion that

gas engines have reached that point in their development at which they must be considered seriously by all persons interested in the production of electrical energy. The gas engine at the present time is disadvantageous on account of its high cost and by reason of its limited overload range. It is not quite so reliable as the reciprocating steam engine or steam turbine, but it is more economical in operation. There is an urgent demand for a device which is capable of recording continuously the quality of gas supplied to the engine in order that the engineer may be informed at all times as to the conditions under which the engine is operated, just as the steam gage furnishes the equivalent information to the boiler room attendant.

A. I. E. E. Papers on Telephone and Telegraph Systems.

AUTOMATIC TELEPHONE SYSTEMS.

Mr. W. Lee Campbell presented a paper at the Atlantic City convention of the A. I. E. E. giving an outline of the operating features of automatic telephone switchboards and a complete discussion of their economic value in comparison with manually-operated boards. The saving relates not only to the elimination of the expense connected with the switchboard operator, but more largely to the decrease in the cost of the external wiring. The author stated that even at the peak of the load 98 per cent of the cable and wire equipment in the average telephone system is not in use. When an automatic system is installed, the number of "substations" can be largely increased, thereby decreasing the average length of the subscribers' circuits, while the service is not impaired thereby because an automatic trunk connection consumes only 83 seconds as compared with 120 seconds for a manually-made connection.

WIRELESS SIGNALING.

A paper by Mr. R. A. Fessenden dealt with wireless telegraphy and telephony. After giving a historical review of the development of wireless telegraphy, the author explained the differences between the damped-oscillation method and the sustained-oscillation method of transmitting messages wirelessly and outlined the advantages of the latter method. The success of wireless telephony depends upon the use of sustained oscillations. Three things are necessary: 1. Means for radiating a stream of electrical waves sufficiently continuous to transmit the upper harmonics on which the quality of the talking depends. 2. Means for modulating this stream of waves in accordance with the sound waves. 3. A continuously responsive receiver giving indications proportional to the energy received, and capable of responding with sufficient rapidity to the speech harmonics. The author stated that the fine inflections of the voice are brought out much better and the transmission is considerably more distinct by wireless telephone than by wire line, due to the fact that there is no electrostatic capacity to distort the speech, and to the absence of telephone induction coils with iron cores. He expressed his belief that there is a field for wireless telephony for long distance lines over land and water and from ship to ship and ship to shore.

Electricity and Fire Protection.

In a paper discussing electricity from the viewpoint of the insurance engineer, read at the Atlantic City convention of the A. I. E. E., Mr. G. M. Goddard called attention to the fact that while the annual per capita loss by fire in Austria, Denmark, France, Germany, Italy and Switzerland averages 33 cents, that in the United States is $2.47, the average total annual loss in this country for the last 32 years being $134,000,000. He claimed that at least 50 per cent of the fires are due to carelessness. He expressed his belief that it was most fortunate for the electrical interests that fire underwriters had begun to appreciate the necessity of fire protection before electricity was generally introduced, so that they immediately began to surround it with necessary and proper restrictions. No small part of the progress of electrical engineering has been due to this fact. At the present day all undue hazards from electricity are being guarded against. Electricity furnishes the safest illumination, and the safest source of energy, for industrial purposes. He entered an urgent plea for co-operation between electrical and fire underwriting interests, so that restrictions shall not obstruct but safeguard the advance of electrical undertakings.

Electric Heating.

Mr. Charles E. Waddell, in a paper read before the Atlantic City A. I. E. E. convention, outlined the reasons for substituting electricity for other mediums for producing heat at Biltmore House and related the experience with the electric heating equipment. A description of this equipment was given in our issue for Oct. 5, 1907. The house is heated by hot water circulated by gravity. Energy at the rate of 30 kw is supplied at 230 volts, three-phase. The furnace which this heater replaced consumed 10 lb. of anthracite coal per hour. The author said that energy can be purchased at 0.85 cent per kw-hour and anthracite coal at 0.5 cent per pound. It would seem, therefore, that the electric heater cost 25 cents per hour and the furnace 5 cents per hour. However, the furnace required more attendants than the electric heater, and there was considerable cost and annoyance connected with the handling of coal and ashes.

CENTRAL STATION

MANAGEMENT, POLICIES AND COMMERCIAL METHODS

Day Load for Electric Light Stations.

By James Francis.

Specialization has been the rule for a number of years in most branches of manufacturing, but there are times when it is not desirable in the electric lighting field. When a $50,000 or a $100,000 power plant is lying practically idle all day, in order that it may pay expenses at night, the owners are certainly justified in casting about for some addition to their business which will enable the power plant to become profitable by day. Usually the day load can be made to pay all operating expenses, leaving the legitimate business of lighting a source of net profit.

In casting about for a day load something outside of electrical matters must usually be adopted—a fact to be regretted for obvious reasons. Some electric light station managements have added ice making for a day load. Another concern put in a wood-working plant and found that the refuse from the wood-working establishment went a long way toward the necessary fuel supply. But both the concerns the writer has in mind made serious mistakes in installing their day equipment, as they added steam engines for driving their day load, consequently they were unable to operate any portion of their original night equipment except the boilers.

Another station added a water-works for a day load, and after 15 years of experience, even with partial natural gas fuel, the management found it could buy energy from a neighboring street railway company cheaper than it could generate it in its own station. The company made the mistake of operating separate engines for driving generators and pumps instead of electrically driving the latter, thereby making necessary only one economically driven engine instead of two comparatively wasteful steam-using machines, the 10-in. pump being a veritable "steam sucker."

It appears very plain that any profitable day load for an electric light station must be an electrical one. This narrows the question down to the obtaining of a day motor load sufficient to load the central station units to a profitable part of their capacity.

When fitted with electrically driven pumps and compressors, ice making will prove a profitable day load for small stations. A saw mill with planing mill attachment, variety wood-working, sash and blind making and furniture factories will prove profitable loads, but it requires all the skill and experience of a manager to keep these industries profitably employed, thereby making it necessary to double the executive force at the very start.

In some localities canning factories offer inducements for day load purposes, such factories not only using some power, but a great deal of steam for cooking and sealing the products of the plant. In remote districts the making of wood pulp, either ground or soda, would prove profitable and would consume an immense amount of energy. But it seems to the writer that the chemical portion of manufacturing should furnish the ideal day load for city or town stations where a day motor load has not been touched or only partially developed. What may be done in this direction may be indicated by the single example here noted, where a plant was added for the electrolysis of salt—chloride of sodium—for the purpose of commercially producing chlorine gas for bleaching purposes.

The electrolysis of common salt results mainly in caustic soda and chlorine gas, the latter used for bleaching purposes, and it may be either combined with calcium as chloride of lime, or it may be compressed into cylinders and shipped thus in the gaseous state. The writer gives herewith a very condensed report of the performance of an electrolysis installation a few years ago in a Pennsylvania town, the chlorine in the case mentioned being used on the spot for bleaching wood pulp in a paper mill, while the caustic soda, which is usually a by-product in making electrolytic chlorine, was used in the same mill for making wood pulp by the soda process. Doubtless, considerable improvement has been made in electrolytic cells for chlorine separation since the apparatus in question was installed, therefore the process may have been cheapened, both as regards efficiency and the life of the diaphragm in the cell, which is or was the great point of weakness in salt electrolysis.

REPORT OF SALT ELECTROLYSIS.

Run commenced 5 p. m., Jan. 24, 1900.
Run completed 4 p. m., Jan. 25, 1900.
Duration of run, 23 hours.
Average voltage, 94.
Average amperage, 600.
Total horse-power, 75.5.
Ampere hours, 13,800.
Available chlorine liberated, 563 lb.
Caustic soda separated, 630 lb.
Salt (chloride of sodium) used, 1050 lb.
Efficiency, 88.5 per cent.
Number of cells, 80.
Production of chlorine equivalent to 1689 lb. of 35 per cent bleaching powder.
Equivalent to 21 lb. from each cell.

From the above data (with improvements down to date) the station manager may approximate possible results in chlorine manufacture as a day load, the proper figures being supplied according to local markets, for the cost of salt, price of chlorine and for the probable market value of the soda by-product.

That the chemical day load will prove both a convenient and a profitable one is self-evident, for the reason that no special machinery is required for the consumption of energy—that is, there is no necessity for the installation of motors or other moving machinery for the purpose, the electrical energy being consumed as generated, the cells or other necessary devices being arranged to fit the output of the generators. When it becomes necessary for the writer to establish a day load for a lighting station and something beyond the ordinary must be instituted, his first step will be to secure the collaboration of a first-class industrial chemical engineer who is also experienced in electrical matters, and work up in the chemical-electrical field something which will not only take the day power, but which will be elastic enough to absorb at any time any surplus energy which may be available, thus enabling the power plant to be operated at all times at the point of most efficient load.

The Handling of Complaints.

By S. H. Williams.

In only a very small percentage of central stations will there be found a realization of the vital importance and interest of the complaint department to the business. There seems to be a tendency to ignore this side of central-station work, caused perhaps by the fact that the great benefits derived from good methods for the receiving and adjustment of claims are not appreciated. Complaint is a word which arouses in one a feeling of sympathy, of patience and of fairness to be extended. A complaint is the tale of a wrong that demands or pleads for adjustment, and no feeling of satisfaction, of contentedness and of security is brought about unless all due attention and consideration is given to the matter.

It is in the manner of receiving complaints that the greatest danger lies. Too often there is exhibited a feeling of impatience, indifference and high-mindedness so that there exists to-day conditions that cause the public rather to expect ill treatment. The complaint department should consist of persons possessing pleasantness, tactfulness, courtesy, judgment of human nature and good common sense.

There is a popular feeling existing to-day against public utility corporations which it is impossible to erase from the mind of the average person by argument, but when he has a grievance and presents it for adjustment then is the time for agreeable relations to be established between the consumer and the central station. The treatment a consumer receives when he appears before a complaint clerk will determine what kind of a consumer he will be forever after.

There are four routes by which complaints are received. First, by call in person; second, over the telephone; third, by letter; fourth, by outside employees. Personal calls offer the best opportunity to adjust nicely and satisfactorily the matter in dispute, because every consideration, attention and courtesy can be extended to the consumer. The second, that of the telephone, is where considerable danger lies, because generally the telephone call is answered by office boys or clerks whose inflated opinion of their own importance, their indifference and lack of interest in their work, result in some very impertinent, discourteous and unsatisfactory attention being given to the consumer when attempting to file his claim for adjustment. A certain manager, in order to avoid all risks of such an occurence, answers personally all telephone calls each evening between the hours of 5 and 7 o'clock and thereby insures that they receive prompt and proper attention.

The third route, that of the letter, is where the least danger lies, because this is generally attended to by some one in authority who is able to understand matters better. The fourth, that of outside employees, is one in which a representative of the company, generally a meter indexer or collector, receives the complaint. Too often the employee is in such a great rush to get over his route that he gives very little attention to, and many times fails to report upon, the complaint at all. A complaint should be listened to attentively and reported to the complaint clerk, and it should receive the same careful attention as if the consumer had called personally. The delay caused by a non-reportal makes the inaction of the company to straighten matters out a ground to grow seeds of discontent.

Complaints received are of such a nature as to be easily classified into two general headings, "bills" and "service," and as such will be considered below. Those received in regard to "bills" require more prompt treatment than do the service complaints, as a rule. There are a great many schemes and methods to explain lucidly and satisfactorily to a consumer the cause of his bill being more than, in his opinion, it should be. In the first place, there is an individuality about every high-bill complaint brought about by the various conditions connected with each individual case so that no set rule can be adopted for the handling of all cases, yet it is possible to adopt a general method by which the desired information can be obtained.

In any event, a complete report of the consumer's side of the matter in dispute should be obtained before any opinions are ex-

pressed or suggestions are offered to him. After this information has been obtained the company's data can be referred to and the two can be compared, and from the evidence thus secured a fair, broad-minded position can be taken in the matter. It is essential that the company's policy having once been declared, nothing can come up afterward that would require an admission, a withdrawal or a retraction.

Consider as a sample case an ordinary one that arises every day in the year. John Jones, who has been a consumer of electrical energy for some time, owns a small dry-goods store which is lighted by 20 16-cp lamps in the store proper and 20 in the windows. When Jones receives a bill for April he believes it to be extremely large; he looks up his old bills and calls at the company's complaint department. He states in all honest belief and intention that his electric-light bill for the month of April of $15.85 was considerably more than the one rendered for the month of March, and was larger than the one rendered for the same period the year previous. Moreover, during the year he reduced his equipment by 20 16-cp lamps and did not increase the number of burning hours—in fact, used the service less. These facts leave no loophole, in the mind of Jones, for the company to escape. It is not possible for such a thing to occur unles there is something radically wrong somewhere, and he believes the meter to be the seat of trouble. Jones, having laid before the complaint clerk a general statement of his complaint, the next step for the complaint clerk to consider is a very practical one. The central station has only the meter for ascertaining just what a consumer uses, and if the meter has been read correctly, has been tested and found to be in first-class condition and registering correctly, then in so far as the general station is concerned the matter is ended. To prove this to Jones, however, is another thing.

One method which the writer has found to be very reliable is to check the statement rendered by the meter by means of information furnished by Jones. It matters little how many test cards he is shown, he will not be assured that the meter registered correctly during the time the bill was contracted. In reply to questions Jones said that 20 lamps were used three hours each night, and on Saturday night the total equipment was used for six hours. Now there are four weeks in the month, so that one may calculate as follows:

16-cp lamps	20
Burning hours	3
Lamp-hours per night	60
Nights per week	5
Lamp-hours for five nights	300
16-cp total equipment	40
Burning hours	6
Lamp-hours Saturday	240
Lamp-hours during balance of week	300
	540
Weeks in month	4
Lamp-hours in month	2160

A 16-cp incandescent lamp consumes 56 watts, and the rate being 12 cents per kw-hour, a 16-cp lamp-hour costs 0.00672 of a cent, or, roughly, 7/10 of a cent. Therefore, with 2160 lamp-hours per month the bill should be $15.12. The actual figures as registered by the meter amounted to $15.85, but the difference of 73 cents which exists is very small and can be accounted for in many ways. The force of the result of his own statements in regard to the burning hours being sufficient, Jones was convinced in the matter offhand and departed satisfied.

Service complaints are more or less of an entirely different nature, and they do not require undue explanation. Nevertheless, prompt, courteous and satisfactory attention must be given to accomplish results. In the electrical business, as in every other, people will be encountered who want a great deal more than there can be given to them, and in dealing with such people the idea is to make some sort of an arrangement by which they will be entirely satisfied with what they get.

As an illustration, a certain merchant who had a panel sign, which was painted in an ordinary way, announcing the fact that his name was so and so, saw elsewhere a sign of the block-unit type with which he was much pleased. In order to induce the company to furnish a new sign, he made all sorts of complaints; the lamps did not operate properly, they were not large enough, the sign swung too much and he was afraid it would fall on some one; moreover, it cost too much to operate. Finally, after considerable thought a diagram was prepared and colored of a panel sign painted and lettered entirely different from any other in the city and from any he had ever seen. He was pleased with this sign, which he is now using. The result was obtained merely by patient, painstaking consideration; just a matter of presenting an old thing in another light.

In case of poor-service complaints, low voltage, interrupted service, blackened and burned-out lamps where they are exchanged free, requests for rearrangement of street mains, painting of arc-lamp globes to prevent glare in bedroom, placing of poles, wire attachment, through any number of complaints and requests, the public feeling toward a central station will be increased to just the extent that the company exhibits a desire to do the right thing promptly. Promptness is a condition brought about by system. Therefore, to expedite matters one must use some system and method; in the complaint department the necessity for system is very apparent. A system covering the "bill" complaints would be one of routine to be followed by the complaint clerk and one covering "service" complaints would be one involving various orders and records.

The proper view to take of the complaint department question is that every opportunity should be availed of to secure praise from the consumer for the service rendered by the company. To accomplish this result the service must be prompt and thorough in every respect; if not, the company should learn very quickly concerning any shortcomings or defects. This method brings the consumer and the company into closer relationship with each other. Promptness and courtesy cost very little, but the returns from them are valuable.

Pertinent Considerations on Power House Locations.

BY E. D. DREYFUS.

The rapid progress made in the art of electrical manufacturing and the increasing demand and application of electricity has caused frequent supercession of the machinery in use and replacement by apparatus of higher efficiencies, greater capacities and improved designs and characteristics. The past five years or so have witnessed vast and extensive improvements in the early electrical installations, and with the large number of stations, particularly in the smaller cities which still have the early types of apparatus in service, there is to be expected a renewed activity in the renovation and rehabilitation of such plants as soon as normal conditions throughout the country have been restored.

Technical papers and manufacturers' literature treat comprehensively of the improvements and advancements made in the various types of apparatus, and information concerning such machinery can easily be obtained. Practically but limited information relating to the selection of a power-house site has been published, and the intent of this article is to give herein a résumé of various important considerations bearing upon this subject for use as a ready reference. However, it will not comprise such features as are exceptionally special and occurring only occasionally in a few certain localities.

The items which appear most essential are as follows: (a) Real estate; (b) center of load of the system; (c) available water for cooling; (d) coal delivery facilities, and (e) character of soil for foundations. These items have not been listed in order of their importance as the preponderance of any point over that of the others or vice versa will be influenced altogether by the local conditions prevailing.

A general survey of the property and system or proposed layout will show in an offhand way the relative standing of the points under discussion, and a more analytical examination will prove their value in the considerations to be made.

In addition to the points above enumerated, special reference should also be given to the neighborhood or locality in the vicin-

ity of the available sites together with whatever insurance restrictions or regulations govern the sections under consideration.

Sufficient reference is rarely ever paid in any preliminary engineering work to the conditions affecting the cost of carrying insurance on the plant. Where the risk is not provided for by the company itself in writing off a predetermined amount to the credit of the insurance account, or if it is not placed with a mutual company organized for the protection of its members or the like, the insurance expense, as a rule, will be considerable.

The insurance tariffs established by old-line companies depend upon the building construction, radiating exposures, fire protection and conflagration hazard, and the "loading charge" will vary approximately from 1 to 3 per cent according to how closely the installation complies with the standard insurance requirements. It very seldom happens that the premium falls below the percentage stated, but, contrarily, the rates will often exceed the higher limit. However, on a standard fireproof, semi-fireproof or slow-burning construction of modern design, a rating of three-quarters of 1 per cent or less may be obtained where full insurance is carried. Should these facts be lost sight of, a company may be induced to locate its power station at a point where high insurance rates prevail on account of the surrounding conditions. All questions of insurance are generally left to the management after the plant has been constructed and placed in operation. However, it can be seen from the above remarks that it might often fall within the power of the engineer to control the insurance burden to an extent by proper selection of the power-house site. The importance may be brought out more forcibly by taking an example where protection is secured to the full value of the plant, and the premium or loading charge is 3 per cent or more of the risk. Say, the outstanding bonds (sold at par) which were issued, for example, in this case, in amount equal to the construction value of the plant, and on which the plant has to pay 5 per cent interest. Therefore, more burden is imposed upon the management if 3 per cent additional is to be paid for on this investment for insurance carried covering its appraised value before a surplus is made and dividends can be declared on the company's stock. A certain amount of insurance should be carried at all plants in order that the investors' capital may be suitably protected.

Should a power house be located near a residential district, the property owners will sometimes enter objections and even lawsuits on the least provocation, as in the instance of the emission of small volumes of smoke from the chimney when cleaning and splicing fires or from other reasons, such as the noise from gas-engine exhaust, odors from producer plants, etc.

Another point which may prove profitable in certain cases is the acquisition of sufficient adjacent property to encourage the location of such plants alongside of the station which might be termed corelated in operation, as ice and cold storage plants. By these means arrangements could possibly be perfected whereby a better all-day load and also a more even load throughout the year could be obtained, such as to keep the machinery working more up to capacity, thereby deriving larger returns on the investment.

In the consolidation of the gas and electric businesses, all other things being equal, it is desirable to have the two types of plants adjoining in order to economically use common labor between them and also facilitate the supervision of them by the general superintendent or manager.

Real Estate.—After locating the different available properties and determining the more desirable sites from physical and electrical standpoints, the value of the lots acquired must be weighed in balance with the advantages any one location has over another. It might not be out of order to mention at this point that the company or its engineers should use discretion in negotiating for the property, and often the object of the purchase is and should be disguised inasmuch as the price will be considerably advanced, on account of any particular advantages afforded, when the purpose of using same for a power-house site becomes known. This is frequently done through reliable real estate agents or by some individual serving for the company. The value of real estate is more indeterminate and variable than any other consideration herein; that is, after a general survey of the lay of the land has been made and all other requirements and factors are known. There is no fixed market value as a general thing for such property, and the aid of a shrewd buyer may prove profitable. When options on desired sites for stipulated sums have been secured, then the engineering and commercial considerations involved can be undertaken with more accuracy.

Center of Load.—The center of load, or what is often termed the electric center of gravity of the system, is of paramount importance. The amount of copper required in the distribution system increases in proportion to the square of the distance of the power station from this center of load, providing that a fixed voltage (or even compensating voltage) is maintained at the generating station and a predetermined full-load drop is allowed in the feeders and mains of the distributing system, which is the usual practice. Central stations should have an intimate knowledge of the teritory served, conditions of distribution, trend of development and extension, etc. The electric center of gravity of the system can be readily obtained graphically by taking the various distributing centers, transformers, or where feeders tie in with the distributing mains, and by designating the amount of current supplied at these points, and proceeding with the determining of the center of gravity in exactly the same manner as is done in obtaining the center of gravity of an unsymmetrical body. The fact that certain districts lying within the territory supplied or to be supplied might offer special advantages for development in the way of residential locations or factory sites should be borne in mind as the probabilities are it will gradually shift the center of load unless this development is equal in all directions, which is only a remote possibility.

Available Water for Cooling.—Where there is more than one point or source where ample circulating water is obtainable, the different waters should be analyzed and their ingredients and action determined. This pertains to whatever use is made of the water, as for condensing, boiler feeding or jacket cooling. In some cases where it is difficult to obtain cooling waters, the economy of operation under regular loading conditions and the increased cost of the installation should be worked out accurately and the warrantability of condensing, if any, demonstrated. Lack of attention to these matters often means a case of robbing Peter to pay Paul. In endeavoring to operate condensing in small- and medium-size plants, attention is often given the installation of cooling towers. Where this is done, due consideration must be taken of the load factors on the station, and where a low load factor prevails the advisability becomes questionable. The warrantability of cooling towers, and even the condensing apparatus itself, where ample circulating water is available, can readily be determined by balancing the annual saving in coal consumption against the increased cost of maintenance and operation, together with the increased fixed charges of the station.

Coal.—In any section where a station is installed the location of the nearest coal fields where the coal mined would be available at fair prices at this destination should be carefully reviewed, together with the transportation facilities at command over various rail or water routes. The steaming or gasifying qualities of these coals should be properly considered, and further in regard to the applicability to various furnace designs. The extent of the production of the coal, local representation and other factors affecting the delivery of the fuel should all be taken into account. This leads us to the condition of the local terminal delivery as to the possibility of unloading from barges, obtaining spur tracks from one or more railroads, ascertaining switching charges, if any, on change of car routing, providing elevated coal trestle, if practicable, making provision for coal storage where there is a likelihood of suffering from coal shortage or famine, having means for the prompt unloading for coal on heavy shipments to avoid demurrage, and arranging for the disposal of the ashes.

Foundations.—The importance of this subject requires no emphasis. When examining the sites available the soil should

be thoroughly investigated, test borings made and their character studied. Some soils in certain localities are very treacherous, and it is desirable to consult builders in these sections regarding such conditions, and ascertain what is the best (local) practice in dealing with them. With large rotating machinery, and especially the reciprocating type, firm and unyielding foundations are imperative. If the soil conditions are poor and it is necessary to employ special foundations and piling, the relative advance in building cost will be considerable in the small plants, and this must be borne in mind when necessary to reduce the cost per unit of installation to a minimum. Generally speaking, hard rock beds, where of sufficient depth, afford the best sub-foundations, compact sand and coarse gravel are next in order, and firm clay has a very good bearing power. Sandy beds will not withstand any great pressure, and made ground, alluvial soils and quicksands will require substantial reinforcing.

There are various characters of soils encountered in the same section, and the disposition of the seams or strata are so irregular in places that all these conditions must be carefully determined in order to properly select and design the foundations and sub-foundations to prevent settling and throwing the building and machinery out of alignment.

The number of test borings necessary depends upon the character of the underlying seam or stratum. If a few borings show any considerable variations in the different sections, then sufficient borings should be made to ascertain completely the worst conditions with which you have to contend.

Many of the conditions cited above may be only trivial in some places, while in other cases those items considered least important may become serious factors in the successful and economical operation of a property.

The management will more or less have to contend with the popular demand for reduced rates from time to time and arbitrate new schedules, and, therefore, to pay interest charges on the funded debt and earn reasonable returns on a legitimate capital stock issue, it is most desirable that every point of vantage be exploited.

There are other contingencies encountered possibly in different quarters than alluded to herein, but what has been cited will, it is believed, prove food for thought for those who have not heretofore taken to this subject more seriously.

INTERIOR WIRING AND ILLUMINATION

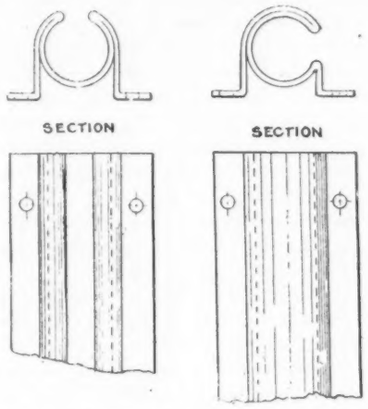
British Conduit for Use in Interior Open Wiring.

The accompanying illustrations show a type of conduit devised by Mr. Gladman Sarney, of England, for preventing the internal condensation of moisture. Figs. 1 and 2 show two alternative forms of the conduit. Fig. 3 shows a jointing clip which is used for connecting conduits together, and to the various bends and fittings.

The conduit consists of an open tube, not merely with a close joint, as in ordinary "socket" conduit, but having an opening in the form of a wide gap which is smaller, however, than the maximum internal diameter of the tube. Flanges are provided along the whole length of the conduit for fixing purposes, holes to take screws or nails being punched wherever required. Use is made of only one type of clip, by means of which the conduit is made continuous, and this is used also for attaching tees, bends, inspection boxes, etc. The tube lengths are not, therefore, joined up by loose sockets, but by these clips, which do not cover the gap, but merely grip the flanges underneath the tube, and preserve the alignment of the lengths. It will be seen that the flanges keep the tube clear of the surface of walls against which it is fixed and permit of a free passage of air all round, thus providing against unequal temperatures, while the wide gap in the tube itself allows of the rapid dispersal in the air of any moisture which may be deposited inside.

The system is applicable only to interior surface work or to concealed work where it is not necessary to bury it in plaster or cement.

In wiring, the conductors are either threaded through while



FIGS. 1 AND 2.—ALTERNATIVE FORMS OF SARNEY CONDUIT.

making the runs or laid in the tube, after erection, through the gap, the inventor claiming that the wires will remain in position owing to their natural bends causing them to "take up" within the conduit. Alterations and additions can be readily carried out because it is necessary merely to pull out the wires from any

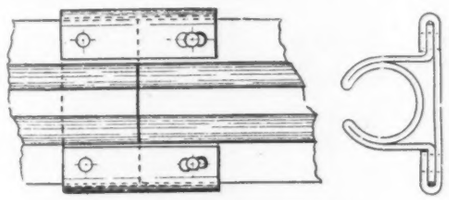


FIG. 3.—CLIP FOR JOINTING.

length of conduit at the point of alteration, and after cutting the tube and inserting the necessary junction box or tee, to replace the wires as before. This method saves a great deal of time and labor over the older methods.

Adapter Transformer for Single Lighting Units in House Illumination.

One of the disadvantageous characteristics of the metallic-filament lamps resides in the fragility of the filament when a lamp is constructed for moderately high voltage and low candle-power. That is to say, the filament of a 16-cp, 110-volt tungsten lamp must be microscopic in diameter, while that of a 100-cp, 110-volt lamp or of a 16-cp, 10-volt lamp of the same type would be much larger and far less fragile. It is difficult to render a small high-efficiency lighting unit designed for the ordinary commercial lamp circuit e.m.f. satisfactorily "shock proof." A solution to the problem of utilizing high-efficiency lamps of low candle-power when the supply e.m.f. retains its normal value which has been suggested, consists in the use by each customer of a house transformer to reduce the e.m.f. to, say, 25 volts. According to another solution, use is made of an "adapter" transformer with each lighting unit. A recent issue of the London *Electrical Engineer* contains a description of a transformer of the latter type which has been developed by the London Transformer Company.

The transformer is placed in the lamp socket like any ordinary lamp, and the low-pressure lamp is placed in a socket provided at the lower end of the transformer. The diameter outside the cylindrical case is 1⅞ in., and the total length, including a

"turn-down" switch, described later, is 5½ in. The weight is about 1½ lb. The "adapter" transformer is a pure transformer with separate primary and secondary windings. An advantage of this arrangement is that the secondary winding is not at the same potential as the primary winding, as is the case in an auto-transformer. As the transformer is placed on the lamp side of the switch, the no-load losses will not have to be considered.

In the construction of the transformer, a single core of high-grade iron strip is insulated, and first the primary and then the secondary winding is put on. The ends of the strips are then bent round at both ends and both sides to form a closed magnetic circuit. On account of the modern methods of insulation employed in the manufacture of the "adapter" transformers, a very high space factor is attained. The finished transformer is enclosed in a bright polished brass sleeve, and spun brass caps are fitted to each end of the sleeve. The continuous rating of the standard type is somewhat over 20 watts, and the usual arrangement is to use one of these in conjunction with one 16-cp, 25-volt lamp, or two 10-cp, 25-volt lamps.

An ordinary carbon-filament lamp consumes 3.75 watts per candle. Most metallic-filament lamps consume about 1.2 watts per candle. The efficiency of the "adapter" transformer is 85 per cent, consequently the combined transformer and lamp will consume less than 1.5 watts per candle. Thus, in spite of the unavoidable loss in the iron and copper of the transformer (about 3.5 watts in all), a saving of over 60 per cent is thus obtained.

At a slight extra cost a turn-down device can be fitted to the transformer. By twisting the lamp socket, the lamp terminals are brought in contact with stationary contacts connected to different points on the secondary winding. There are three positions: (1) 25 volts (full voltage), corresponding to the full candle-power, say, 16; (2) 20 volts, corresponding to about 10 cp, and (3) 5 volts, which gives a mere glow suitable for a night-light in the nursery or sick room. In many cases, where the lamps are within reach, this means of varying the candle-power of the lamp will be found very convenient.

"ADAPTER" TRANSFORMER TABLE LAMP.

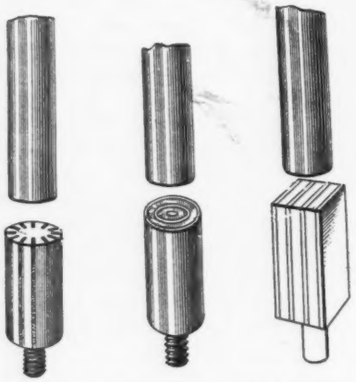
A convenient arrangement of the "adapter" transformer is indicated in the accompanying illustration, which shows a table lamp containing one of these transformers in its pillar, and equipped with the above-described turn-down device. The possibility of reducing the light in this way, with corresponding economy in consumption, makes the lamp specially suitable for bedrooms, nurseries and sick rooms. A neat switch in the primary circuit renders it unnecessary to remove the socket plug to switch off the light, and the brilliancy is regulated by simply rotating the lamp shade. The transformer may be detached from the base and used suspended from an ordinary lamp socket if desired. In the case of house installations with a high-voltage supply, in which electric fans and heating appliances are employed, a general change over of the whole house circuit to 25 volts would be inadmissible; with the aid of these "adapter" transformers, 25-volt metal-filament lamps can be used, the reduced consumption amply justifying the cost of the transformers.

Improvements in Luminous Arc Lamps.

ANODE FOR MAGNETITE LAMP.

A composition electrode for luminous arc lamps for which a patent was issued to Mr. G. M. Little, of Pittsburg, Pa., on June 9, is illustrated in Figs. 1, 2 and 3. The anode shown in Fig. 1 is composed of a rod of iron having longitudinal radial slots in which strips of copper are placed. This anode is used with a so-called magnetite cathode composed of a mixture of magnetic oxid of iron which is a conductor both when hot and when cold and which gives conductivity to the electrode, oxid of titanium which imparts appropriate color and brilliancy to the arc, and oxid of chromium which steadies the arc and prevents the electrodes from being rapidly consumed. Such a cathode has usually been employed in combination with a copper positive electrode which is very slowly consumed.

In operation with a copper anode of the lamp there forms on the anode a slag that is composed of the oxid of copper, a very poor conductor when cold, which prevents electrical contact between the electrodes and consequently interferes with the ready starting of the lamp after it has once been in use. For this reason it has been proposed to employ iron for the positive electrode or some other metal, the oxid of which is a conductor. Iron, however, is more rapidly consumed than copper and what has been termed "pooling" frequently occurs when it is employed; that is, the arc plays upon a comparatively small portion of the end of the composition electrode until the surface becomes hollowed and a depressed pool of the molten oxids forms, upon which the arc moves rapidly, resulting in flickering of the light.



FIGS. 1, 2 AND 3.—ANODE FOR MAGNETITE LAMP.

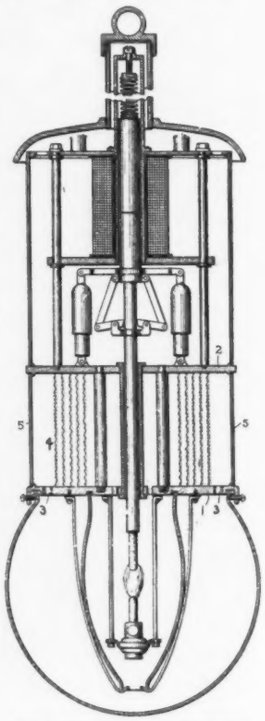


FIG. 4.—STEINMETZ VENTILATED LAMP.

With the anode illustrated in Fig. 1, and the modification shown in Figs. 2 and 3, it is claimed that pooling does not occur and that consequently a steady arc results. The rate of consumption of the electrode is also considerably less than that of iron alone, and it has been found that, if the larger portion of the exposed area is composed of iron, the life of the electrode may even be greater than that of copper alone, the iron serving as mechanical means for preventing scaling of the oxid that forms upon the surfaces of the copper unexposed to the arc, thereby preventing continued oxidation of the copper.

VENTILATION OF LUMINOUS ARC LAMPS.

Experience shows that unless special means are provided for ventilation of luminous or flaming arc lamps the solid matter emitted by the arcs in the form of smoke is deposited upon the inclosing globe, thereby forming a coating which obscures the light to a greater or less extent. On July 7 a patent was issued to Dr. C. P. Steinmetz for an arrangement by which the solid matter is directed away from the air-inclosing globe and is

then removed or eliminated from the air currents which carry it.

The arc which is formed between the electrodes is surrounded by a small inclosing globe open at its lower end as indicated in Fig. 4. The interior of this arc-inclosing globe communicates with the interior of a chamber 4 formed between the plates 1 and 2 and the cylindrical casing 5, this communication being afforded by means of a suitable number of openings in the lower plate. The arc-inclosing globe 26 is in turn surrounded by a spherical or other suitably shaped outer globe. When the lamp is in operation the arc heats the air immediately surrounding it and this air rises through a set of openings into the chamber formed between plates 1 and 2, thereby producing a draft up through the opening at the lower end of the inner arc-inclosing globe. This draft causes air to be drawn from the chamber 4 through suitable openings, some of which are indicated at 3, down into the outer globe. The action described causes a continuous circulation of air from the inner arc-inclosing globe up into the chamber 4, then down from the chamber into the inclosing globe and from thence into the inner inclosing globe, and so on. This directed circulation of heated air from the arc permits the removal of solid matter emitted from the arc almost as soon as it is produced and for this purpose use is made of a series of screens formed of wire gauze of moderately small mesh, these screens being located concentrically in the chamber 4. In the drawings these screens are indicated in cross section, and as shown it will readily be seen that the air which is caused to circulate by reason of the heating action of the arc is forced to pass through these screens before returning to the chamber formed between the inner and outer globes. The solid matter given off by the arc in the form of smoke or vapor is thus deposited in the meshes of the screens, thereby preventing its deposition upon the arc-inclosing globe, the effect of which would of course be to reduce seriously the amount of light transmitted.

LETTERS TO THE EDITORS.

Symbols for Physical Quantities.

To the Editors of the Electrical World:

SIRS:—I have read with interest Mr. Miles Walker's suggestions concerning the adoption of certain picture symbols for electric and magnetic quantities, which may be recommended for general adoption. While Mr. Walker's suggestion appears to me worthy of consideration, and while I must admit that I have frequently used similar notations in my engineering work, I deem it a little dangerous to revert to a pictorial alphabet unless the Latin and Greek alphabets have avowedly failed. It is one thing to use such pictorial method for ourselves in our own work, and another to introduce it generally into scientific and engineering papers in Europe and in America. I am in sympathy with Mr. Miles Walker's arguments in favor of pictorial symbols, and I think that there is a wide and useful field for their use, but I should hesitate to commend them for standardization. The difficulty of using standard symbols for the electric and magnetic quantities is much enhanced by the desire of introducing a generally adopted symbol for every imaginable quantity used. Thus the task of finding standard symbols has not only become a very great one, but the difficulty of obtaining a consensus of opinion has been enormously increased. To the present writer, it would appear that much more rapid progress in this direction could be made if the attempt at standardization were confined to fewer quantities. By thus restricting the number of quantities for which standard symbols are to be adopted, some agreement could undoubtedly be reached and the work in this direction would receive a wholesome start. A writer on a scientific or engineering subject will unquestionable have to call in symbols of his own for which no standards have been generally adopted. There seems to me no objection to this, as even the most ardent believer in standardization of symbols could not possibly wish to restrict the use of symbols to those which may be adopted by the International Electric Technical Commission, or any other scientific or engineering body. If an agreement can be reached in regard to the adoption of symbols for the commonly used quantities, a great step in advance has been secured.

MILWAUKEE, WIS. B. A. BEHREND.

To the Editors of Electrical World:

SIRS:—Mr. Miles Walker's article in the Aug. 8 number deals with a subject of great interest and importance. You point out editorially some of the objections to his proposed solution of the problem; and I beg leave to add a suggestion along the same line.

In order to make practical use of his proposed system of new symbols it would be necessary to have a convenient name for each. It is not practical, in reading a formula, to pronounce words expressing the significance of the symbols. In reading the formula for Ohm's Law, $I = \frac{E}{R}$, we say "I equals E over R," not "current equals electromotive-force divided by resistance." In many cases the only available words to express the meaning of the symbols are even more cumbersome than in the above formula; for instance, g means "the acceleration due to gravity," and π means "the ratio of the circumference to the diameter" and ϵ means "the base of the Naperian system of logarithms."

These illustrations show how necessary it is to have a brief name for each symbol. The prospect of memorizing not only from 200 to 300 new symbols, but also the same number of appropriate names, is too formidable to be calmly contemplated.

This line of thought also suggests a very serious objection to the solution suggested in your editorial discussion, where you point out that there are some 178 symbols already available by using upper and lower case letters, script and Greek. The trouble is that there are not enough names to go around. Witness the difficulty we have in reading a formula where N represents the number of conductors on the armature, and n the revolutions per minute; or a beam formula where L equals the load in pounds and l the length in feet. To be sure, such formulas are fairly common, but they are very annoying, if they are to be used for any more complicated computation than a mere substitution of numerical values. It seems to me that in a system for permanent and general use, not only the form but the name of every symbol should be perfectly distinctive.

Why should we not adopt the principle of the chemical notation as the basis of our universal symbolic system? The chemical symbols of two letters each are numerous and satisfactory. Such symbols as Hg, Cu and Al perform their office in chemical equations without any confusion or misunderstanding. While there are not enough letters to go round, the combinations of letters are unlimited. Let us start with M = mass; L = length; T = time; I = current; E = electromotive force, etc. Then use such compounds as Mt = magnetic induction; Te = temperature; In = moment of inertia; Eg = energy.

There is no great difficulty either in writing or reading formulas made up of such symbols; and although there is a possibility of confusion in listening to the reading of a formula where such an expression as $1/2\ MT^2$ might possibly be understood as $1/2\ Mt^2$, yet generally a knowledge of the matter under discussion would preclude such a mistake. Perhaps, in order to avoid all question as to whether a small letter following a capital is part of a symbol of which the former is the initial letter or is another quantity, it would be well to write the small letter in each case as a subscript. If this were done the biliteral symbols above suggested would be written Mt; Te; In; Eg; and the expression which I at first wrote $1/2\ M^{t^2}$ would become $1/2\ M_{t^2}$.

Of course, we need not be limited to two letters in forming our symbols. For instance, why would not R_{pm} be an acceptable symbol for "revolutions per minute." It would be easy to go ahead on this basis and write out a complete list of symbols for as many physical quantities and mathematical abstractions as might occur to me, using as far as possible initial letters and

suggestive abbreviations. However, such a system should not be founded merely on the English language, but should make the best possible compromise with already generally adopted symbols and with the conflicts between different languages; and, of course, I am not competent to do such a work.

It seems to me that the principle above suggested is the only practicable basis for a universal system of symbols, and that a system so constructed might meet with general acceptance and prove substantially satisfactory.

South Framingham, Mass. M. V. Ayres.

Motor-Control.

To the Editors of Electrical World:

Sirs:—Referring to Mr. S. H. Sharpsteen's article on printing-press motor control in your issue of Aug. 8, I wish to call attention to the fact that the movable arm *L* in Fig. 5 must be provided with a special resistance contact for use on the first five contact studs leading to the battery. I realize, of course, that Fig. 5 is only diagrammatic, but at the same time feel that the necessary difference in construction between plain rheostatic control and control by an "end cell switch" should be indicated.

It may be of interest to some of your readers to note the simple expedient that I have used in starting a gasoline engine, used for charging batteries. This engine, a six-cylinder affair of 70 hp, would start nicely on the spark after a short shutdown, but if this failed it was a very hard task to turn it over by lever and ratchet. No adequate starting resistance being available, the following connections were made:

The field is run direct from the battery. Left throw of the double-pole, double-throw switch gives just enough current to turn the engine over nicely; in fact, at so low a speed that even after it takes hold and the throttle is opened wide, it cannot accelerate because of the heavy charging current delivered to the 12 cells. This period of slow turning gives an excellent opportunity to study the valve setting and ignition and to regulate inequalities that cannot be noticed at high speed.

New York. Harold M. Martin.

Limitation in Engineering Specifications.

To the Editors of Electrical World:

Sirs:—Engineers in preparing specifications often, unintentionally perhaps, bar numerous manufacturers of electrical apparatus from an opportunity to submit a bid or have their apparatus included by some bidder in a lump sum tender. Of course, in large installations competition is naturally narrowed to a comparatively small number of concerns, but the writer refers more particularly to the numerous installations of moderate size in office buildings, industrial plants, etc.

Usually, in the prelude of the specification, are the clauses relating to the right of the engineer to reject any or all bids and that all material is subject to his approval. In the face of this one would expect the widest latitude in the choice of material as long as the intent of the specification is filled and the engineer satisfied. If the intending bidder has that idea in his mind, however, he is quickly disabused as soon as he comes to the section covering the various parts of the plant.

In the selection of a dynamo he will be limited to three or four makes, sometimes less, while you can look at the advertising index of an electrical journal and find the names of at least 15 or 20 reputable manufacturers who would be glad of an opportunity to have their product used. This holds good all along the line, the same limitation is extended to engines, boilers, motors, switches, switchboards, circuit-breakers, instruments, etc., all of which lines are manufactured by numerous concerns who have brought their product up to a high point of refinement, but are barred by this limitation.

Then usually comes a long detail section on the design of the various pieces of apparatus, all of which fattens up the specification and tends to make the client look upon it with awe, but is really only repeating factory specifications which are common to all standard types of apparatus and have been approved by the various electrical and mechanical bodies.

The position of the engineer who claims that this limitation safeguards his client is hardly tenable, as it is safe to say that no two or three concerns have a monopoly of engineering ability along any one line. Instead, by this policy, the tendency will be to stifle the healthy competition which insures that the competing concerns in the various lines shall keep their product up to its maximum excellence.

The engineer, from the nature of his calling, is supposedly a broad-minded man, but by this limitation certainly narrows the field and loses an opportunity to enlarge upon his own knowledge as, being protected by the rejection and approval clause, he is in a position to make the manufacturer inform him, and have points brought forward in argument that would materially assist him perhaps in some future problem. Thus, while the policy of limitation is a handicap to the manufacturer who is barred from the competition, it is also not without its effect upon the engineer and client.

Less limitation would also tend to produce more cordial relations between engineer and manufacturer, as now the manufacturer is often obliged to assume the duties of the engineer in order that he may open a market for his product which has been closed to him by the engineer naming specific material to be used.

Providence, R. I. Henry O. Allen.

Testing Underground Cables.

To the Editors of Electrical World:

Sirs:—The article on "Insulation Resistance" by Mr. Hugh T. Wreaks in your issue of Aug. 8 brings out some points worthy of careful consideration. I have often wondered how far the National Electrical Code is lived up to, as I have rarely seen tests taken on installations, and in the few instances when this has been done, the means employed were in no way adequate.

I am engaged in testing telephone cables, and we test every cable about three times a year, while for the most important cables our specifications require a test every two weeks. I have occasionally been called upon to test power installations for insulation, when I used a Leeds & Northrup portable insulation set in connection with a portable silver chloride battery of about 90 volts. The results obtained were similar to those obtained by Mr. Wreaks.

The tests should be made in every possible combination of the cables in order to determine the slightest defect. The chances, of course, are very small that two cables will be punctured in the same place, and this justifies Mr. Wreaks' desire for a jump-spark test.

An example from practice may explain this more fully. In the case of a dead-ended cable, test showed a solid ground, but a little pull on one end of the cable improved its condition and a further pull made it appear as perfect. The insulation was found to be torn off near the duct, and the cable was just touching the duct during the first test. If the cable had slipped only an inch further, the probabilities are that the fault would not have been found until it caused trouble. This shows that care must be taken in these tests, and that at least the ends of the cable where they emerge from the dust should be moved during a trial test. In the duct itself where the cables retain their fixed position, they are less liable to "go back on the tester."

Philadelphia. Max Freimark.

Tabulation of Engineering Data.

To the Editors of Electrical World:

Sirs:—I wish to call attention to the use, or rather the abuse, of figures which frequently appear in the technical press in connection with the tabulation of engineering data. I refer in particular to the article, "Amperes in Alternating-Current Circuits," by Mr. A. D. Williams, published in your issue of Aug. 8.

"In making the computations * * * the amperes were computed for various values of e.m.f. to a sufficient number of decimal places to insure accuracy."

That the conception of accuracy was both vague and inconsistent may be seen from the fact that part of the table was computed to 1 per cent accuracy (1 part in 96) and another part to 0.001 per cent accuracy (1 part in more than 100,000). Most of the table uses four or five places of significant figures.

Now, the average computer will make use of all the figures he can collect in the course of a computation. Given engineering data of two, or at most three, places of figures, he will, in the course of arithmetical operations, or by multiplying by such absurd constants as given in the table, arrive at a result with six, eight or possibly more significant figures. Nothing will convince him that only three of these have any meaning. The loss of labor from such use of figures is enormous, as each addition to the number of significant figures nearly doubles the labor of computing. Especially serious is the jump from three to four places of figures, for this step throws out the use of the slide rule.

It is very seldom, indeed, that all of the data of an engineering problem are stated accurately to more than three places of figures, or that a result is required to more than three places. The exceptions may be classed as precision work rather than engineering. An apparent exception is in relation to certain fiscal calculations, not estimates, where accounts must check to the cent.

On the principle of a chain which is not weakened by the addition of any link stronger than the weakest, the use of a slide rule in engineering calculations does not lessen the accuracy of the result, since the slide rule is almost invariably more accurate than the least accurate of the data. The true results of any physical problem being always an unknown and incommensurable number, the result given by a slide rule is as reliable as that of the most laborious of hand or machine calculations, and has the advantage that it does not give a misleading array of meaningless figures in the result.

Tables, such as those referred to, usually condemn themselves. The co-ordinates increase by steps of 5 or 10 per cent and the curves of power factor are separated by steps greater than 5 per cent. In practice a double interpolation is necessary and it is impossible to do this with much accuracy in the third place of significant figures, and none at all in the fourth place. The use of superfluous figures is a nuisance to one who knows how to reject them and a serious cause of waste labor to others. An engineering plot laid down to 10 times the accuracy with which an indicating instrument can be read will not allow any such ridiculous arrays of figures as given in this table.

To save the time of an army of computers who do not and will not understand the economical use of figures, I suggest that in the publication of engineering data the number of significant figures be limited to three, these, of course, being independent of the position of the decimal point, which has nothing to do with the accuracy of an array of figures.

TRENTON, N. J. H. S. PARDEE.

DIGEST OF CURRENT ELECTRICAL LITERATURE

Abstracts of the important articles appearing in the electrical periodical press of the world

Generators, Motors and Transformers.

Direct-Current Turbo-Generators.—J. S. S. COOPER.—An illustrated article on European practice with reference to direct-current turbo-generators. The field core is commonly of quite special construction, being provided both with commutating poles and coils, and with a compensating winding in slots in the pole face. The armatures are remarkable for their comparatively small diameter and relatively great length. It is necessary to balance the armature mechanically both before and after winding. The mean voltage per commutator bar will be high, while the time of commutation will be short, so that commutation troubles and flash-overs are to be expected unless special provisions are made to overcome them. A slightly increased thickness of mica is often employed for these reasons. It has also been proposed to obviate these difficulties by inserting, between each pair of ordinary bars in the commutator, another bar of intermediate voltage, but not intended to carry the main current. One suggested method is to take a tap from the rear end of each armature coil and connect it to the intermediate commutator bar, as shown in Fig. 1, where the auxiliary wind-

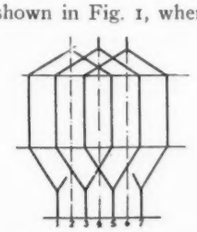


FIG. 1.—DIAGRAM OF ARMATURE-COIL CONNECTIONS.

ing is indicated by dotted lines connecting the rear ends of the coils to bars 2, 4, 6, etc. The voltage of bar 2 is, of course, half-way between those of bars 1 and 3, but bar 2 does not carry the main current of the machine. A modification of this idea has been suggested by Miles Walker, who has embodied it in a 1000-kw machine. Half the induction of one coil is obtained, not as above, by going once through the core, but by going twice through half the core. This is shown in Fig. 2, where the core is divided into two parts, *A* and *B*. The main winding runs through as usual, and is connected to commutator bars 1, 3, 5, 7, etc., while bars 2, 4, 6, etc., are connected to the special winding shown by dotted lines. This winding, of small cross-section, is tapped off the main conductors in the space *C*, and passes to the proper slot by involute connectors in this space. It is subject only to the induction of the part *A* of the

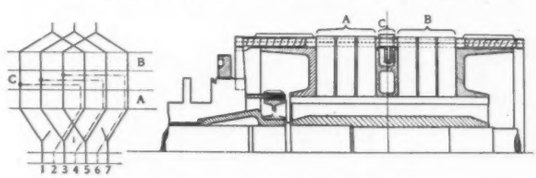


FIG. 2.—DIAGRAM OF CONNECTIONS.

core, so that there is between bars 1 and 2 just half the voltage that there is between bars 1 and 3. It is obvious that this idea could be extended, and that by dividing the core into three or more parts, several intermediate bars could be inserted, thus dividing the voltage between the main bars into any number of equal parts. The insertion of these intermediate bars in the commutator not only improves the commutation, but greatly diminishes the chance of a spark holding across the mica and developing into a flash-over. At the same time the compensating winding maintains an even distribution of flux and therefore of voltage, and prevents the voltage between any two bars from rising much above the mean value. Since at high speeds there is always some vibration, it was formerly considered necessary to use metal brushes, but it is now recognized that carbon brushes are preferable. Special brush gear design is discussed, and the construction of a "radial" commutator is described in which the brushes are pressed against the flat faces of a series of disks. High-conductivity graphite brushes are used. The wear on the radial commutator and its brushes is very small, but the first cost is somewhat higher than with the usual type.—*Elec. Jour.*, August.

Iron Losses in Transformers.—M. G. LLOYD.—A theoretical and experimental study of the effect of wave-form of the primary e.m.f. upon the iron loss in a transformer. Results

are given of experiments in which various wave-forms were used with commercial types of transformers. The different wave-forms were obtained by using simultaneously generators giving sine waves of frequencies 60, 180, 300, 420, 540, 660, 780 and 900 cycles per second when running at normal speed. The phase relations of the several generators are adjustable, and as they are mounted upon a single shaft, remain invariable during an experiment. By connecting these the armatures of these generators in series and exciting each to the proper voltage any desired wave-form which involves only the odd harmonics up to the fifteenth may be procured. The chief conclusions are as follows: With a given effective electromotive force the iron losses in a transformer depend upon the form factor of the e.m.f., and vary inversely with it. With a given form of wave the effect upon the iron losses may be computed approximately from the formulas derived by the author, providing the higher harmonics are not prominent. By proper design of the generator supplying energy to the transformers, the iron losses may be reduced to a minimum.—*Bull. Bureau of Standards,* Vol. IV, No. 4.

Losses in Three-Phase Motors.—K. Simons and K. Vollmer.—A translation in abstract of their recent German paper on the shape of the current curves in three-phase motors and the separation of the losses. It is pointed out that by means of the oscillograph several phenomena occurring in electric machinery can be conveniently studied. The paper is intended to clear up in this way certain unsettled points with regard to the losses in three-phase motors, thereby avoiding the aid of mathematics, which would become too complicated.—Lond. *Elec.,* July 24.

Theory of Commutation.—J. Bethenod.—A mathematical note in which the author shows how the orthodox theory of commutation must be modified on account of the irregularities in the edges of the brushes and commutator segments. These edges are not always exactly parallel in practice and the variation of the contact resistance is, therefore, more rapid than is assumed in the orthodox theory. The modified theory leads to a new condition under which the current density will not become infinitely great at the moment when the circuit is broken, and it appears that the new condition is more easily fulfilled than the condition given in the orthodox theory.—*La Lumière Elec.,* July 18.

Thermometer for Dynamo Tests.—F. Leconte.—The author has devised a special thermometer with very thin glass-walls for measuring the temperature of a commutator. He claims that the indications of ordinary thermometers are always too low. While his new thermometer does not yet give the exact temperature, it is much better than ordinary thermometers. Any covers of cotton or wool should be avoided. The influence of the friction of the glass on the commutator and the effect of the eddy currents produced in the mercury are discussed.—*La Lumière Elec.,* August.

Lamps and Lighting.

Nernst-Lamp Filament.—W. W. Coblentz.—An account of an investigation of the Nernst-lamp filament in which the distribution of the flow of radiant energy in the spectrum was determined at different specific power consumptions and hence at different temperatures. For several filaments the apparent black-body temperature, corresponding to different values of specific power consumption, was measured with an optical pyrometer, for red, green and blue light. The results are of interest in showing the variation in selective emission with rise in temperature. A series of flow of energy curves was obtained, varying the power consumption from 16 watts (the lowest at which the glower would conduct without using a transformer) to 123 watts, which is far above the normal. The energy-flow curves, which were continuous, underwent great variations in appearance with rise in temperature. At 2.5 and 3.5 μ there would generally appear in the curves elevations and depressions which could not be attributed to experimental errors. At the lowest temperatures (800 to 900 deg. C) the bands in the region of the long wave-lengths are the most intense. As the temperature increases, the bands in the region of 2.5 μ increase very rapidly in intensity, so that when the temperature has increased from 1000 deg. to 1100 deg., the intensity of the group of bands at 2 μ is far in excess of that at 5.5 μ. The depression at from 3 to 3.5μ persists even at normal specific power consumption. The curves at higher temperatures often show a slight depression at 2.5 μ not attributable to experimental errors. As the temperature rises new emission bands appear, notably at 2.5 μ and at 4 μ. This shift of the maximum intensity of the bands, with increase in temperature, is to be expected, if the emission is a purely thermal one, following Kirchhoff's law, and is the most conspicuous illustration yet recorded. From all the results obtained it is evident that even after the emission spectrum has become apparently continuous it does not follow so simple radiating laws as have been established for other solids emitting continuous spectra. It is also evident that any estimations of the temperature of the glower, based on these laws, will lead to erroneous results. From a commercial point of view, the luminous efficiency of such a radiator, in which the emissivity is abnormally high at from 0.6 to 0.7 μ, while the maximum at 1.2 μ is abnormally low, must be much higher than that of substances having a radiation law similar to that of platinum, in which case, in order to attain a similar intensity in the visible spectrum, the maximum at 1.2 μ rises to extremely high values. By integrating the energy-flow curve and taking the ratio of the visible to the infra-red radiation (it has been customary to take the dividing line at 0.76μ) it is possible to obtain a rough estimate of the luminous (white light) efficiency for a given power consumption. This gives values varying from 3.6 per cent at 27.7 watts, 5.5 per cent at 83 watts to 7.4 per cent at 123 watts.—*Bull. Bureau of Standards,* Vol. IV, No. 4.

Magnetite Arc.—C. A. B. Halvorson.—An illustrated description of the system of street lighting in Worcester, Mass., where series-luminous arc lamps (copper-magnetite) are used. A table gives interesting comparative figures on the operation of the ordinary direct-current open arc and of the magnetite arc in practice.—*Gen. Elec. Rev.,* August.

Generation, Transmission and Distribution.

Electric Transmission for Main Marine Propulsion.—W. P. Durtnall.—A paper read before the Institution of Marine Engineers in London on generation and electric transmission of energy for main marine propulsion and speed regulation. The paper dealt in a general way with the application of the Hart-Durtnall three-phase electric transmission system for marine propulsion, and sought to emphasize the great possibilities of electrical transmission and speed regulation as applied to steam-propelled vessels, and the economies obtainable. In the author's opinion, electric transmission can be successfully carried out only by means of polyphase alternating currents with synchronous generators and squirrel-cage induction motors, not only on account of the great simplicity of these machines, their low cost and low weight per horse-power developed, but also because the use of direct-current machines with commutators and brush gear would be next to impossible for such high powers as would be necessary. Comparative figures were given showing the possible saving and operating cost in the use of this system.—Lond. *Elec. Eng'ing,* July 23; Lond. *Electrician,* July 31.

French Power Station.—A. Solier.—An illustrated description of the power plant of Brillane-Villeneuve, in southern France, 70 miles from Marseilles. It is a water-power plant, containing five 3000-kv-amp alternators, running at 1250 r.p.m., and producing three-phase currents at 7500 volts with a frequency of 25. For transmission the e.m.f. is raised to 50,000 volts in 15 single-phase transformers, each of 90 kw.—*La Lumière Elec.,* Aug. 1.

Gas Engines.—An illustrated article on the recent trip of English engineers to Germany for the purpose of inspecting several large gas-engine plants.—Lond. *Elec.,* July 24.

Traction.

Single-Phase Railway.—An article on the London, Brighton & South Coast Railway, which is the first British single-phase railway. Each train will consist of three cars, the first and the last of which are motor cars, each being equipped with four

125-hp motors. The total seating capacity of each train is 188. "A modified form of side-entrance compartment coach has been designed so that in case of any one compartment being full, passengers can pass into the next without having to leave the carriage, this arrangement giving greater convenience to passengers and saving time at the stations." As regards the electrical equipment of the line, the overhead conductor, which conveys electrical energy to the motors, consists of a heavy grooved solid wire, ½ in. in diameter, which is supported at every few feet by means of dropper wires suspended from standard steel catenary cables, which are, in turn, suspended from massive porcelain insulators through a double insulation which has been tested to 10 times the working e.m.f. The insulators are supported upon specially designed steel structures. Due to the constantly varying nature of the line on this section, a very great number of different types of support had to be designed, the strength of these having been calculated on the basis of a factor of safety of 10 to 1, which has in all cases been worked to in the overhead equipment. In order to meet the conditions which have been imposed as regards voltage-drop in the return circuit, a special system of cables was rendered necessary and a duplicate feeding system has been provided throughout the line. In order to avoid all possible danger of electromagnetic interference with the many telephone and telegraph circuits which exist along the line, the overhead wires in the majority of cases have been removed and the circuits carried in lead-covered air-space cables, metallic returns being substituted for earth returns in all cases. The generating plant consists of four 2000-kw alternators.—Lond. *Elec. Eng'ing*, July 23.

Capacity and Rating of Railway Motors.—N. W. STORER.—The author urges that a complete and correct statement of the proper rating of a railway motor is more important than any particular method of rating. If a rating is desired for comparative purposes, it may be given in the continuous load in amperes, but all calculations should be based on complete information which should be furnished by the manufacturer, as follows: 1, the curves of speed, tractive effort and horse-power of the motor within the limits of its commutating range and mechanical strength; 2, a statement of the currents the motor will carry continuously at 300 volts and at 400 volts; 3, a curve showing the allowable time any load above the continuous current may be carried when the motor is already heated in service; 4, a curve showing the time over which the motor will carry any load with a rise of 75 deg. C., starting cold.—*Elec. Jour.*, July.

Surface-Contact System.—A note stating that the G. B. surface-contact system which has been successfully operating for three years at Lincoln, in England, has proved so inefficient on a trial line in London that the surface-contact cars have been withdrawn and horse cars have been substituted. The manufacturer claims that certain alterations in the system had been made by the tramway engineers against their protest and that the lack of success is due solely to these changes.—Lond. *Elec.*, July 31.

Gasoline-Electric Drive.—F. BROADBENT.—The author first gives figures from active practice showing the saving which can be obtained by the gasoline-electric drive and other mixed systems over pure electric drive or pure gasoline drive for certain purposes of traction. He thinks the mixed system is especially suitable for omnibuses, and that it will be advantageous also on many suburban lines.—Lond. *Elec. Rev.*, July 24.

Rail Corrugation.—M. LASSALLE.—An article tracing the causes of rail corrugation to alternations of slip-and-roll or skid-and-roll, and pointing out a possible connection between this phenomenon and the characteristics of the series motor. This may explain why corrugation appears mainly on electric railways.—Lond. *Elec. Eng'ing*, July 23.

Installations, Systems and Appliances.

Switchgear.—An illustrated description of a high-pressure ironclad switchgear of English make. It comprises a line of standard switch units of the ironclad type which may be combined to form panels to meet all the requirements existing on high-pressure networks. The system fulfils the important requirement of interchangeability with the advantage that extensions or alterations to similar existing gear can be accomplished at short notice. The gear has been developed in conjunction with the Merz-Price system for feeder and transformer protection.—Lond. *Elec. Rev.*, July 24.

Manchester.—An account of the last yearly report of the municipal electricity works of Manchester. The number of kw-hours sold has increased from 47,564,903 in the preceding year to 63,437,088 in the last year, while the total cost per kw-hour sold (including capital charges) has decreased from 3.258 to 2.758 cents in spite of an increase in the cost of coal.—Lond. *Elec. Eng'ing*, July 23.

Wires, Wiring and Conduits.

Heating of Conductors.—L. ROY.—A highly mathematical paper illustrated by diagrams, in which the author discusses the heating of a wire by an electric current. The terminals of the wire are assumed to be connected to metal pieces of relatively large mass. By a generalization of Fourier's theory, the general solution of the problem is given and two different special cases are then considered, the variation of the resistivity with temperature being taken into account. In the first case the current is held constant and in the second case the voltage at the terminals is held constant. Applications of the theory are then made to incandescent lamps and to the calculation of fuse wires.—*La Lumière Elec.*, July 25 and Aug. 1.

Relay Connections.—H. W. BROWN.—An article describing the various methods of connecting some of the more common types of relays to the line. Illustrations are given in each case of the rear of both the external and the internal connections of the instruments. The author discusses the connections of overload instantaneous relays, of alternating-current overload time-limit relays, of reverse-current relays and of auxiliary relays.—*Elec. Jour.*, July and August.

Electrochemistry and Batteries.

Storage Batteries.—F. A. WARFIELD.—An article on the care and maintenance of storage batteries. In conclusion the author gives the following practical rules: Never discharge a battery to an e.m.f. below 1.75 volts. Never adjust the specific gravity of solution by adding acid until the cause of the change in specific gravity is found and remedied. Never allow the acid to get below the standard level, that is, 1 in. above the top of the plates, otherwise the plates may become exposed and sulphate rapidly. Always maintain the acid at the specific gravity specified by the maker of the battery, by testing and adjusting at least once in two weeks. Never let the battery stand in a discharged condition; it should be immediately recharged. At frequent and regular intervals give the battery a good overcharge at a low rate. Keep the battery and all connections clean. Keep all electrical connections tight. Remedy all trouble immediately. Use only pure water and pure acid for the electrolyte.—*Elec. Jour.*, August.

Units, Measurements and Instruments.

Standardization Apparatus.—E. F. NORTHUP.—A Franklin Inst. paper on standardization apparatus for measuring volts, amperes and watts. With respect to direct current, the potentiometer null method is simple and accurate for making all direct-current standardization. With respect to alternating currents two methods are first discussed. In one the potential is measured by an electrometer calibrated with an absolute electrometer and converted into volts by the ratio of the electromagnetic to the electrostatic unit. In the other the potential difference is determined by measuring the very small current which exists in a high and non-inductive ohmic resistor. This latter method is advocated as being probably the more accurate and better adapted to commercial requirements. But it is desirable to measure alternating voltages and currents by a null method and for this purpose the alternating-current direct-current comparator has been devised. It is shown that it may be used as a companion instrument to the potentiometer and thus all voltages and currents, both direct and alternating, can be measured directly in terms of standard e.m.f. and resistance. The precision of the alternating-current measurements may be

made equally high throughout the range of measurements if a sufficient number of high-resistance units and low-resistance shunts are at hand to maintain the sensibility of the comparator about the same, regardless of the volts or amperes being measured. Experience shows that this result is practically accomplished if a new resistance value and new low-resistance shunt be used each time the voltage or current being measured is doubled in value. To measure very large currents the mercury ammeter has been developed; this is based on the "pinch" effect. The author then discusses briefly the method in which a sensitive electrodynamometer, with a low-resistance astatic moving system, is employed with non-inductive shunts to carry the main current being measured. Finally the standardization wattmeter is dealt with and the most essential features in its construction are described.—*Jour. Frank. Inst.*, August.

Wave-Form of Magnetic Flux.—M. G. Lloyd and J. V. S. Fisher.—An illustrated description of an apparatus which was designed and constructed in the course of measurements upon the magnetic losses of energy in sheet iron. Its object was the determination of the average value of an alternating e.m.f. from which the form factor of the e.m.f. wave and the maximum value of the magnetic flux inducing it can be computed. It serves equally well, however, for the tracing of a wave of magnetic induction. The essential part of the apparatus is a rotating commutator which reverses the contacts twice per cycle. An ebonite disk is mounted on a shaft and to its circumference is fastened a thin conducting strip with gaps at two points 180 deg. apart. Four brushes, equally spaced, bear upon the metal rim of the rotating disk, and their joint action is that of commutation. By means of a worm-and-gear the brushes may be set in any desired position. The brushes are insulated from each other. One opposite set of brushes is connected to a secondary coil wound around the flux to be measured, while the other set of brushes is connected to a direct-current voltmeter. To plot a curve of magnetic induction, a reading on the instrument is taken for a definite position of the brushes. Then successive readings are taken, the brushes being advanced the same number of degrees each time until they have been shifted through 180 deg. The authors give the theory of the method and examples of its use.—*Bull. Bureau of Standards*, Vol. IV, No. 4.

Phantom Grounds.—R. F. Howard.—A municipality installed a plant for street and house lighting, all the feeders being lead-sheathed and underground. On starting up the plant the ground detector indicated grounds on the system. Much time and money were spent in trying to locate the faults. The ground detector consisted of a voltmeter of the switchboard type operated from the low-tension side of a 15-watt potential-transformer, 2000-to-100 volts, and so arranged that one terminal of the transformer could be connected to each phase lead of the generator and the other terminal connected to ground. When used in this way the voltmeter always gave some indication. However, no grounds really existed on the system, the indications being due to condenser effect, since with the ground-detector connections as stated, there was sufficient charging current in the transformer winding and voltmeter to make the instrument read and give a false indication. Another case similar to the above was investigated recently where an alternator was reported "grounded." The alternator was connected to a bank of transformers and it was known that a ground existed on the system, which was afterward found in one of the transformers. The observer had taken readings on a voltmeter from the three terminals of the machine to ground, and concluded that this was sufficient proof of the generator being grounded. The reason that the voltmeter read in this way was that the armature winding of the alternator had considerable capacity to ground, and a circuit was made through the voltmeter when connected as described. Very different results were obtained by using transformers of various ratings to operate the voltmeter; the highest reading was obtained when using a voltmeter transformer, but with a 5-kw transformer there was no deflection. The indications on the voltmeter would depend upon the voltage impressed on the high-tension side of the transformer. The different voltmeter readings with the different transformers are accounted for by the fact that the magnetizing and iron-loss currents varied considerably in the different sizes used. The smaller the transformer the higher the voltmeter reading. The 5-kw transformer required a magnetizing current that would cause most of the drop to be across the place where the condenser effect existed.—*Elec. Jour.*, August.

Oscillograph.—H. H. Galleher.—An illustrated article on various applications of the oscillograph on the test floor where it may be used as an indicating and recording voltmeter, ammeter, wattmeter, frequency meter, power-factor meter, etc.—all combined in one—and fulfils all requirements in a very satisfactory way. The importance of knowing the wave-form in taking a magnetization curve is pointed out. The oscillograph is also very convenient in the investigation of the power factor. While the oscillograph was formerly a very delicate instrument, there are now several forms of oscillographs on the market which are portable and which can be set up and operated by a person with ordinary electrical engineering ability and which, when damaged, can be quickly repaired by any ordinary instrument man or mechanic.—*Elec. Jour.*, July.

Photometer.—F. Loppe.—An illustrated description of the Biegon von Czudnochowski photometer, which is a modification of the Lambert-Rumford photometer, and is claimed to be especially suitable for the comparison of sources of light of different colors.—*L'Industrie Elec.*, July 10.

Wave-Form Analysis.—P. M. Lincoln.—An article illustrated by diagrams describing the method of J. Fischer-Hinnen for resolving a complex wave into its components, and illustrating the method by an example.—*Elec. Jour.*, July.

Grissonator.—J. de Beaupre.—An illustrated description of the "Grissonateur," which is an apparatus intended to replace the ordinary interrupter for induction coils when used in connection with Roentgen tubes. The grissonator consists of an electrolytic condenser of large capacity in series with the primary of the induction coil. The connections are changed by means of a revolving commutator whenever the current is decreased with zero.—*La Lumière Elec.*, July 25.

Testing Instruments.—An illustrated description of various ammeters, voltmeters, wattmeters, galvanometers, potentiometers and general testing sets made by Siemens Bros. & Company.—Lond. *Elec.*, July 24.

Telegraphy, Telephony and Signals.

Damping Constants and Distance of Transmission.—M. Klein.—It is usual to assume that the simple relation $a\,l = c$ exists between the damping constant of a of a telephone line and the distance l of transmission, c being a constant. c is considered to be independent of the construction of the line and of the receiver; figures varying between 2 and 4 are given (if l is given in kilometers) according to the quality of transmission required over the line. The author shows that this is not generally true, but only if lines of a similar character and with the same type of receiver are compared. The distance of transmission l is always less for a loaded line of the Pupin system than for a homogeneous unloaded line, which has the same damping constant, a. Further, by diminishing the impedance of the receiver without changing its time constant, it is possible to increase the distance of transmission; but this increase is less for Pupin lines than for ordinary lines. Only for lines of a similar type and employing the same receiver is it correct to assume that e^{-al} is constant.—*Elek. Zeit.*, July 30.

Miscellaneous.

Electric Accidents; Hand-Lamps.—An account of the last annual report of G. S. Ram, the inspector of factories in England. There were in 1907 330 non-fatal and 11 fatal accidents in electric generating stations and substations, but only 56 of the non-fatal accidents and three of the fatal accidents were of an electrical nature. In other factories and engineering works there were 258 non-fatal and 8 fatal electrical accidents, which is practically double the number of two years ago. The increase is probably due to the more extended use of electrical energy in factories. One of the fatal cases was due to the absence of

any protection on a three-phase medium-pressure motor-starting switch. Another fatality shows the necessity for properly protecting insulated wires when they are liable to damage. The report deals at great length with the danger in the use of hand lamps as ordinarily constructed and points out that this danger can be easily guarded against. The two most important points to be borne in mind in the design of a lamp for use in dangerous places, that is, where the user is in connection with earth, are (1) that there shall be no metallic connection between the lamp-holder and any other metal part of the fitting, and (2) that the flexible wires in passing from the lamp-holder shall not be taken through a metal tube or be otherwise touching any metal part of the fitting. Fig. 3 shows a very simple and inexpensive type of lamp. The body is made from a piece of oak, about 3½ in. in diameter at one end and turned down to form a handle. The flexible wires pass through a hole down the center to the lamp-holder, and are clamped near the end of the

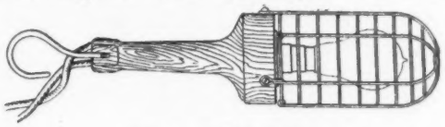


FIG. 3.—HAND LAMP.

handle, so that no strain can be put upon the connection in the lamp-holder, which is of the "batten" type, and is screwed to the flat disk end. The wire cage is attached by screws to the outside of the disk. There is no metallic connection between the lamp-holder and the wire cage, and there is no other metal used in the construction of the fitting, except the hook at the end of the handle used for the purpose of hanging up the lamp. This hook should, however, be replaced by a leather or other non-

FIG. 4.—HAND LAMP.

metallic loop, as with constant use it might injure the insulating covering of the flexible wires where it rubs against them just beyond the end of the handle. The body of another safe hand-lamp, shown in Fig. 4, is of wood. The lamp-holder, which is of the "cord-grip" type, is fixed in a vulcanite ring or cylinder, which is extended so as to form a guard or sheath completely surrounding it. The wire cage is attached to a metal ring, which is screwed to the outside of the wood base. There is no possibility of any metallic contact between the cage and the lamp-holder. The lamp-holder is supported in such a way as to give a large insulating surface between it and the metal cage ring in view of preventing leakage by a film of moisture if the lamp is used in a damp situation. The only weak spot appears to be in the metal hook, which, however, can, without any difficulty, be replaced by a leather or other non-conducting loop.—Lond. *Electrician*, July 24, and Lond. *Elec. Eng'ing*, July 23.

NEW APPARATUS AND APPLIANCES

The New Westinghouse Nernst Lamps.

The most important improvements that have been made in the Nernst system of illumination since it was first commercially introduced into America are to be found in the new Westinghouse Nernst lamp now being placed on the market.

These lamps are of two classes—single-glower provided with

FIG. 1.—SINGLE-GLOWER LAMP.

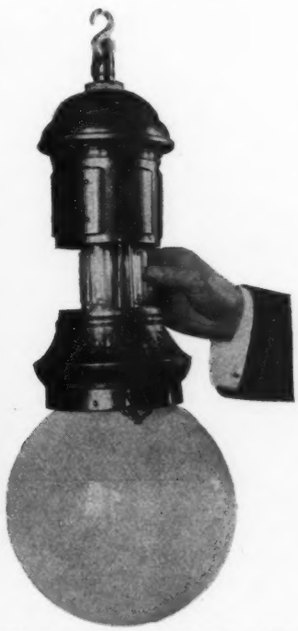


FIG. 2.—MULTIPLE-GLOWER LAMP.

screw base, and multiple-glower with terminal posts. The single-glower lamps are also provided with screw burners, while the multiple glowers are equipped with improved prong holders; otherwise the chief difference between the two consists in mechanical construction.

The single-glower lamps are made in four different sizes, 66, 88, 110 and 132 watts, which provide a larger range than formerly available. The 132-watt unit gives greater candle-power than the old two-glower unit, while the new three-glower gives the same candle-power for 396 watts that the old six-glower gave for 528 watts. Comparing these two units further, the new three-glower requires but one heater and three glowers, while the old six-glower required four heaters and six glowers. Since the new heaters are listed at the same price as the old, and the new glower at but a slight advance, this means a great difference in the cost of maintenance; and since there are fewer parts to handle, it also means a great difference in the time required to attend to maintenance.

A new combination of glower material embracing three important rare earths whose properties have only lately been discovered, increases the glower efficiency of the various units about 33 1/3 per cent.

The most noticeable feature about the single-glower lamps is the screw burner which combines the new glower and the wafer heater in a single piece of rugged construction. It makes renewal practically the same as in ordinary incandescent lamp practice and does away entirely with glower and heater mounting. The same pattern of heater is used in multiple glower lamps, but provision is made in their case for renewing the heaters and glowers separately. The renewal of the heater is accomplished by simply slipping out one wafer and inserting another in its place. This operation does not require the removal of the glowers and in no way injures them.

FIG. 3.—SCREW BURNER FOR SINGLE-GLOWER LAMP.

In addition to the construction of the glowers and heaters,

the multiple glower lamp differs from the former design in practically every mechanical feature. The lamp body is more artistic and pleasing in design, and its appearance is improved greatly by a provision for concealing the terminal posts. It is furnished in several different combinations, including chain and pipe pendants and canopies which are furnished as a part of the unit. The ballast is larger and much more rugged. It is provided with a bayonet spring base instead of plugs, which greatly increases the facility of replacement. On account of its rugged construction it is capable of withstanding heavy voltage fluctuation.

A new type of globe holder is provided, which admits of easy handling and prevents breakage. The glowers are made in tubular form instead of solid, and operate at 0.6 instead of 0.4 amp, thus requiring less handling in renewal for equal current consumption.

Single-Phase Commutator-Type Elevator.

Fully appreciating the demand for a first-class single-phase elevator motor, considerable time and money have been expended by several manufacturers in an endeavor to perfect such a motor.

Fig. 1 illustrates a single-phase elevator motor recently brought out by the Century Electric Company, of St. Louis, Mo., which is built in 5, 7.5 and 10 hp ratings. The company claims that safety, simplicity and durability have been kept foremost in designing this machine; while a very high power-factor and fairly high efficiency have been secured, the fact has not been overlooked that even these characteristics are by no means desirable in too great a measure if obtained at a sacrifice of simplicity or durability, or by the introduction of automatic devices requiring a trained expert to adjust the motor to its circuit and start it, or an abnormal amount of skilled attendance for its maintenance.

The motor is a repulsion-induction commutator machine, being in principle of operation substantially equivalent to the century single-phase constant-speed induction motor while in starting condition, but it differs from that motor in that it is designed to operate normally with the commutator in circuit

FIG. 1.—SINGLE-PHASE MOTOR.

instead of having it cut out. It, however, has a centrifugal device which short-circuits the armature at synchronism, thus placing the motor armature on short circuit for the purpose of limiting the speed when the elevator is driving the motor. This device puts the commutator back in service again as soon as the speed has dropped below synchronism by 10 per cent.

Mechanically, the commutator and shaft are very large and substantial, and the commutator is of exceptional size for the current to be carried. The brush holder and brushes are designed with a view to handling the current at the commutator with the minimum of heat, and the manufacturer's efforts along that line are said to have resulted in producing a machine that is practically as free from deterioration at the commutator as a direct-current motor.

In Fig. 2 the curves illustrate the starting characteristics of this motor when used with a non-inductive controller. The curves were taken from a certain 75-hp, 1080 r.p.m., 60-cycle motor, but they are generally characteristic of this line. As will be noted, throughout its entire normal range of operation, the power factor of this motor, while starting with the non inductive controller, is above 80 per cent, and it rises to above 90 per cent at certain points.

Fig. 3 shows the operating characteristics of the motor when all of the starting resistance is short-circuited. These curves

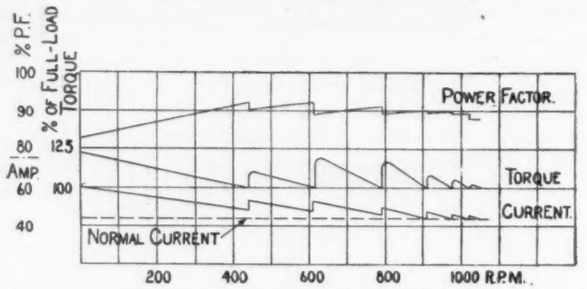


FIG. 2.—STARTING CHARACTERISTIC UNDER NORMAL LOAD WITH CONTROLLER.

cover a range of speed from 400 to 1200 r.p.m., the latter being the synchronous speed of the motor.

Fig. 4 shows an abnormal condition of starting such as might occur in case a motor was very greatly overloaded or with the controller out of order and inoperative. As will be noted from this curve, the ultimate starting torque of this motor is about 400 per cent of the full-load torque and is secured with about 200 per cent of full-load current. Of course, in normal operation a motor will not be required to start five times its rated load, as in general an elevator making a five-second start will require less than 200 per cent starting torque, even when fully loaded. In normal operation the current consumption indicated in Fig. 2 should be little, if any, exceeded.

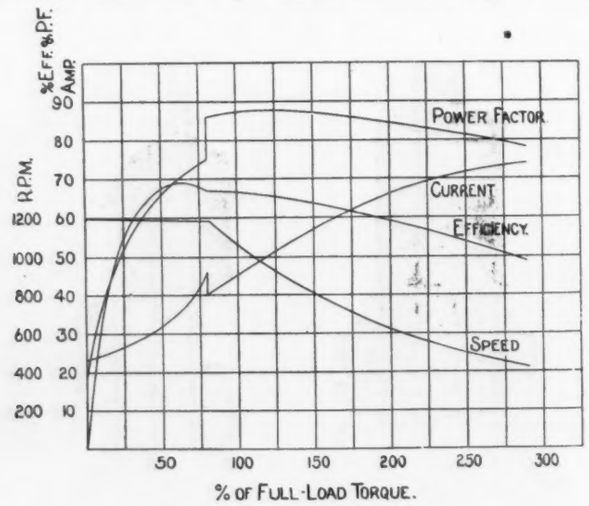


FIG. 3.—RUNNING CHARACTERISTIC.

The curve of Fig. 4 is given merely to illustrate the capabilities of the motor in the event of such abnormal conditions as might require the maximum output.

It will be noted from Fig. 4 that the motor gives 120 per cent of full-load starting torque with 130 per cent of full-load current. In normal operation these motors seldom take from the line in excess of 130 per cent of full-load current; ordinary starts require less than 100 per cent of full-load torque.

No auxiliary inductive devices, auto transformers, slip rings, rheostats or other supplementary appliances are made use of in connection with this motor. A plain reversing rheostatic controller is connected up to the four binding posts of the motor

to give the necessary control; the wiring for the machine, therefore, consists simply in extending the circuit to the controller and connecting this to the four binding posts of the motor.

These motors for 60 cycles are also made for a normal operating speed of 810 and a synchronous speed of 900 r.p.m.

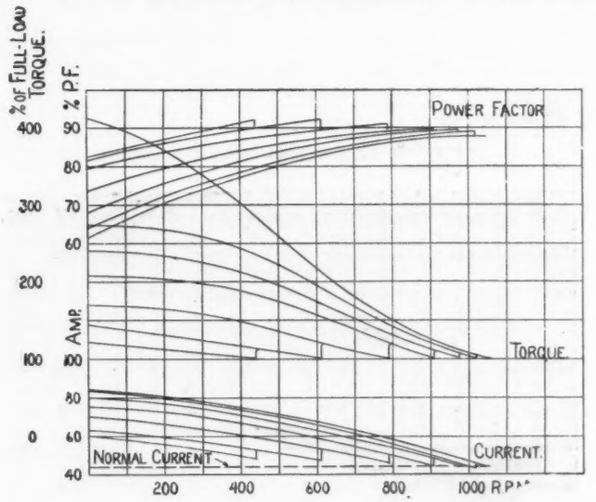
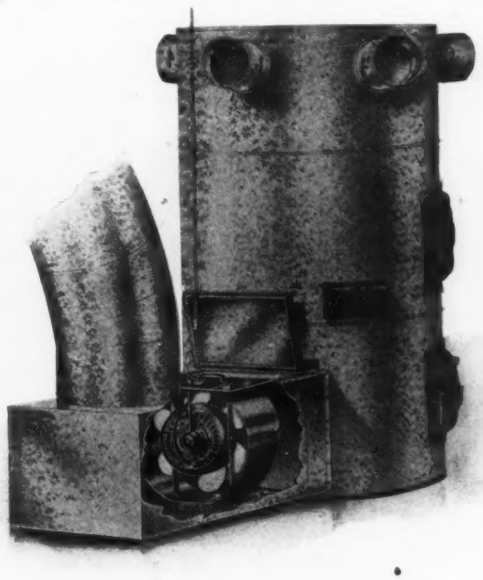


FIG. 4.—STARTING CHARACTERISTIC, SHOWING TORQUE DEVELOPED ON VARIOUS POINTS OF CONTROLLER.

The power factors are not quite as good with the higher-speed motors; aside from this change, however, the slower-speed motors possess about the same advantageous characteristics as do the higher-speed machines.

Electric Blower for Hot-Air Furnaces.

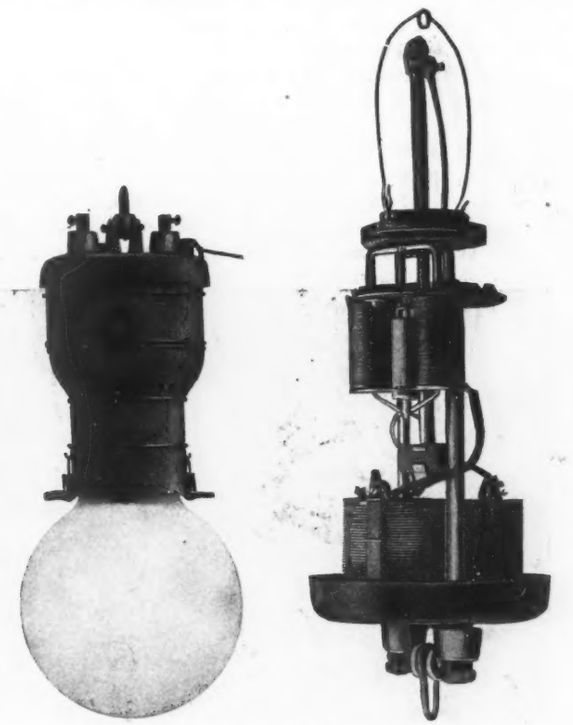
The greatest disadvantage of the hot-air furnace for residence heating is found in the fact that the natural air currents from the furnace fail to heat the rooms on the side of the house exposed to the wind pressure. On the other hand, the hot-air system possesses a marked advantage in that it ventilates as well as heats the building. In order to eliminate the one disadvantage of the system while retaining all of its advantages, use has frequently been made of a common portable electric fan for increasing the direct pressure of the air entering the furnace, and thereby overpowering the external counter pressure against the exposed side of the house. Very satisfactory results have been secured even with this crude method; with a special outfit correctly designed to meet the conditions of the service, a very much higher efficiency is obtainable. The special furnace blower shown in the accompanying illustration is designed to combine extreme durability, quietness of operation and high electrical efficiency, while it may be conveniently installed in new or old furnaces. The blower outfit consists of a special motor equipped with a six-blade quiet fan, and mounted substantially in a sheet-iron casing with a cover and handle. The blower outfit is placed in the cold-air box of the furnace, fitting into an opening about 9 x 15 in. in the top of the box, as shown in the illustration. The action of the fan forces increased quantities of cold air into the air chamber of the furnace to be heated by contact with the surface of the furnace body, and assists the natural tendency of the heated air to rise through the radiating pipes to the rooms above. It is stated that the types of motors furnished with these furnace blowers are the quietest motors yet produced, and operate at comparatively low speeds. While no motor is absolutely noiseless, these types make so little noise that they are inaudible in the rooms above. The above described outfits are built for alternating-current and direct-current service by the Emerson Electric Manufacturing Company, St. Louis, Mo.



ELECTRIC BLOWER FOR HOT-AIR FURNACES.

Mill-Type Enclosed Arc Lamp.

A type of arc lamp for operation on constant-potential direct-current systems, which is claimed to be practically indestructible, is illustrated in Figs. 1 and 2. It is stated that even with the carbon electrodes clamped together and full voltage applied to the terminals for several hours no injury will result to the lamp. The magnet coils are wound with asbestos-covered wire and all the windings in the lamp are fireproof. This construction insures immunity from burnt-out coils whatever may be the exigencies of the service. The lamp is intended for severe and rough service demanded in steel mills, factories, boiler and engine rooms and other locations similarly unsuited to delicate mechanisms. The construction of the lamp has, therefore, been simplified to the last degree, and its parts are few in number, ample in strength, easy of access and thoroughly protected.



FIGS. 1 AND 2.—MILL TYPE ENCLOSED ARC LAMP.

This lamp has been placed on the market by the Westinghouse

Electric & Manufacturing Company, Pittsburg, Pa. It is built in two ratings: 110 volts and 4.5 amp; 250 volts and 2.75 amp. It is said that the normal life of one set of carbon electrodes is from 125 to 150 hours.

Illumination of a Railroad Station.

The Union Station at Schenectady, N. Y., besides being one of the most beautiful on any of the New York Central Lines, has been pronounced by experts to be one of the best lighted depots in the country, and the same opinion is voiced by all

FIG. 1.—ARC LAMP WITH CONCENTRIC DIFFUSER.

who have seen the station illumination. When the lighting installation was under consideration, careful attention was paid to the lighting units from an esthetic standpoint as well as the utilitarian, and as a result they harmonize well with the gray marble finish of the station interior.

The main waiting room is lighted by General Electric high-current arc lamps equipped with concentric diffusers and opal shades, there being three fixtures suspended from the ceiling and three 8-amp arc lamps in each fixture. Each lamp is operated in multiple from the alternating-current, 60-cycle supply circuit. As auxiliaries to the main lighting units, incandescent lights with frosted globes are supported in neat appearing fixtures on the side walls.

Although the arc lamp shown in Fig. 1 is not of the type used in this installation, the illustration will serve to show the relative positions of the diffuser and shade. The lower shade of light opal glass serves to direct the greater portion of the light against the under side of the porcelain-covered metal reflector which, it will be noticed, is slightly cone-shaped and corrugated. The corrugations serve thoroughly to diffuse the light, the rays being directed outward and downward at every con-

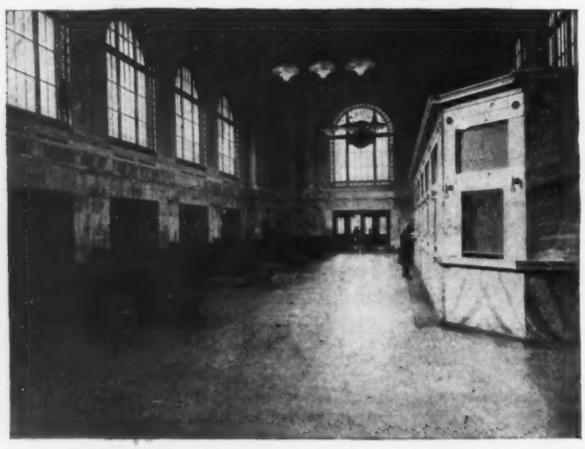


FIG. 2.—DAYLIGHT ILLUMINATION OF STATION.

ceivable angle. The resulting illumination is soft and restful, and the light penetrating to all parts of the room eliminates harsh and unnatural shadows.

Comparing this method of lighting with direct lighting, i. e., with arc lamps without diffusers, the consensus of opinion among engineers and architects is that it is by far the better. Although the intensity of the illumination with this method is relatively quite low, it is easier to read or to see any object in the room, and the general effect is more restful than with direct illumination.

The following tabulation of data is of interest and may serve as a basis of comparison with other installations:

Length of room	103 ft.
Width	44 ft.
Area	4532 sq. ft.
Number of arc lamps	9
Watts per lamp	620
Total kilowatts	5.58
Watts per sq. ft.	1.22
Height of lamps from floor	23½ ft.

The accompanying illustrations, showing the lighting of the

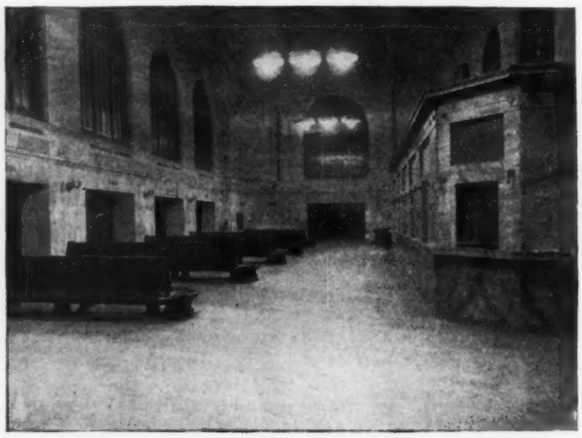


FIG. 3.—NIGHT ILLUMINATION OF STATION BY ARC LAMP.

station by day and by night, while giving a general idea of the installation, fail to indicate the true beauty and effectiveness of the illumination.

Hardened-Iron Spocket Wheels.

The sprocket wheel illustrated in section herewith has been developed by the Link-Belt Company, of Philadelphia, Chicago and Indianapolis, to meet the requirements imposed by the handling of abrasive materials, and by working conditions too severe for the employment of the regular cast-iron wheel. The teeth and rim exposed to the wearing action of

HARDENED IRON SPROCKET WHEEL.

chain contact are hardened to a considerable depth, and the surface made smooth and uniform. This improvement in sprocket wheels is designed not only to make the wheel more durable, but to prolong the life of the chain by maintaining the original accuracy of fit between the links and the sprocket teeth.

The new "flint-rim" wheels are made for most of the sizes of the company's standard type of chains.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.

Trade prospects were distinctly brighter last week than at any time within the past 10 months. Actual business was better and there was every indication that we are standing on the very threshold of general resumption. One feature that lends strength to this hopeful view of the situation is the presence in the market of an unusually large number of buyers—some jobbers say the largest number ever known. Their presence bears out the frequently expressed opinion that retail stocks have been allowed to run very low and that liberal replenishing is a necessity to continuance in business. But it is still the rule that purchases are made with caution and with unusual conservatism, and many jobbers who had built vast air castles on the strength of the great influx of buyers are expressing disappointment at the volume of business already done in August. It is confidently believed that this will be better before the end of the month, although it may yet fell below the rosy expectations of those who have failed to understand that the past year has done more to educate the business public to the wisdom of caution than any of the more serious panics the country has ever known. Physical conditions are all that could be desired. Crops are approaching maturity with better prospects than last year as far as averages go, and with the certainty of larger aggregate yields when the increased acreage is taken into consideration. The condition at harvest in the spring wheat States is not quite as good as was reported Aug. 1, but it is still excellent. Corn, on the other hand, is distinctly improved, the recent rains having helped it all over the entire belt. The certainty of profitable crops and the early beginning of the crop movement from the South and West have done much to help collections, and while they are still slow enough to cause some annoyance, more bills are being promptly attended to than at any period of the summer. The industrial situation is just as favorable as it has been in recent weeks. Gradually more operatives are being put to work, although in the majority of instances mills are running from 30 to 40 per cent behind their maximum. While pig iron has decreased slightly in price, iron and steel manufacturers and allied trades all report some growth in orders and some increase in the number of wheels turning. The voluntary acceptance of a reduced scale of wages by the workmen in the mills at Youngstown, Ohio, was not only of great advantage to those concerns, but was distinctly encouraging as an indication that employees realizing the position in which employers were placed, were willing to bear their share of the burden. Such a sentiment means the end of strikes and the establishment of a reasonable co-operative basis. One of the leading features of the week was the sale at auction in New York of 27,000 cases of staple cotton goods. At this sale the bidding was spirited, prices were fairly good and, taken as a whole, the sale was regarded as a success. In the wool trade there is much cheerfulness and small buyers are in the market in numbers. The meetings of the United Commercial Travelers and the Travelers' Protective Asociation in a joint prosperity congress in New York has, of course, added to the sum total of optimism that is generally prevailing. Every note sounded was for toleration and conservatism and the universal advice was to all members: "talk prosperity." Business failures for the week ended Aug. 13, according to *Bradstreet's*, were 249, against 205 the previous week, 146 for the like week in 1907, 143 in 1906, 147 in 1905 and 203 in 1904.

THE COPPER MARKET.

The reaction in the price of copper, which occurred last week, has demonstrated with absolute distinctness the fact that recent advances were the result of speculation both in this country and in Europe. For three weeks the market climbed steadily upward with trading active and liberal sales being made on both sides of the ocean. When the 14-cent mark was reached there was pause, then a recession. The explanation is not hard to find. As was the case with the stock market at the same time, the profits proved too tempting to those who had pushed up prices and they began gathering in the fruits of their early purchases. Within four days the price of copper that had been advancing for three weeks dropped ⅜ to ½ cent per pound and the pressure to sell was eased off. The strong hands under the advance of copper are making no haste to sell. While enough was let go at the top to cause the recession in price, there was no evidence that the strong speculative account will be liquidated at once. In the meantime the statistical position of the metal continues as far out of line with the trend of prices as possible. It has been frequently pointed out that, with an unusually large production, an unusually small consumption and with enormous stocks being carried, advancing prices were totally illogical. It has been explainable only on the ground that the market is in the control of very strong interests and that the speculative element has all the resources at its command that may be needed to carry through any reasonable program. The extent of the surplus stock of copper in Europe is hardly appreciated. It is enormous. On the first of August the visible supply at London and Liverpool of "standard" was 30,000 tons greater than at the corresponding date last year. It is also estimated that stocks of copper at other points in the United Kingdom were 10,000 tons greater; in Germany stocks of American copper were 24,000 tons greater, and in France 13,000 tons larger. Thus, the total stocks of copper in Europe on the first of August were 77,000 tons greater than a year ago. These estimates are well verified by the United States exports and consumption in Europe. During the first seven months of the year the exports from the United States were 181,780 tons, consumption in Europe during the same period is estimated at 97,288 tons, making stocks of 84,423 tons, but 6276 tons were shipped to China, which indicates a surplus in Europe of 78,147 tons. According to the report of the United States Geological Survey, the stocks at the American refineries Jan. 1, 1908, amounted to 135,745,796 lb. The output of the domestic mines for the first seven months of 1908 is figured at 465,000,000 lb. Add to these figures the imports for the same period, 104,128,000 lb., and we have the total supply of copper for the year, about 704,128,000 lb. According to the government figures the total domestic consumption since the first of the year was 173,000,000 lb. Exports for the same period were 407,175,640 lb., or an apparent domestic and foreign consumption of a little over 580,000,000 lb., leaving surplus domestic stocks on the first of August slightly under 124,000,000 lb. If the European estimates are correct, surplus supplies in Europe of slightly under 300,000,000 lb. seem to be indicated, but even allowing 30,000,000 to 40,000,000 lb. for discrepancy the combined surplus stocks of refined in Europe and America to-day are not far from 400,000,000 lb. Since the first of August there has been some little increase in melting by domestic consumers, and exports are likely to be about 20,000 tons. On the other hand, the prospect is that the domestic production will be slightly increased and the production from foreign ore and matte will be heavily increased, indicating that domestic stocks are likely to be increased 20,000,000 lb. to 25,000,000 lb. during the current month. Exports from Atlantic ports on Aug. 17 were 2659 tons, making the total for August 13,059 tons. On that date prices were again marked down fractionally and there was an abundance of electrolytic offered around 13½ cents, but consumers were evidently anticipating lower figures. The prices quoted on the Metal Exchange Aug. 17 were:

Lake	13½ @ 13⅝
Electrolytic	13⅜ @ 13½
Castings	13⅛ @ 13¼

The London market was as follows:

	Noon. £ s d	Close. £ s d
Standard copper, spot	59 10 0	59 17 6
Standard copper, futures	60 6 3	60 12 6
Market	Weak.	Firm.
Sales of spot		600 tons
Sales of futures		1000 tons

Extreme fluctuations for the year:

	Highest.	Lowest.
Electrolytic copper, spot	13¾	12¼
Lake copper, spot	13⅞	12⅜
Casting copper, spot	13½	12⅛
London, spot	£64 5 0	£56 5 0
London, futures	64 10 0	56 17 0
London, best selected	67 10 0	60 0 0

ROLLER-SMITH COMPANY INCORPORATED.—All of the capital stock of the Whitney Electrical Instrument Company, of Penacook, N. H., and the Switchboard Equipment Company, of Bethlehem, Pa., has been acquired by the Roller-Smith Company, a concern incorporated under the laws of New York July 15, 1908. This is in effect a consolidation of two well-known companies under a new incorporation. All the liabilities of the old organizations are assumed by the new company. The directors of the Roller-Smith Company are: F. W. Roller, president; F. W. Iredell, vice-president; D. R. Smith, treasurer; P. R. Van Wyck and R. S. Taylor. A. A. Whitman is secretary of the company. Mr. Roller, the president of the new company, has been actively connected with the Whitney Electrical Instrument Company and with Machado & Roller for some time, and Mr. Smith has been president and manager of the Switchboard Equipment Company since its organization three years ago. The principal office of the new concern will be at Bethlehem, Pa., but the principal sales office will be at 203 Broadway, New York, in charge of Machado & Roller, sales agents. The Roller-Smith Company will manufacture ammeters, voltmeters, ohmeters, galvanometers, bond testers and circuit-breakers, and such other apparatus as may lie within these general lines. It is the intention to develop further the particular lines heretofore manufactured by both of the acquired companies, and in order to do this to greater economic advantage, the company is now erecting in Bethlehem, Pa., a modern factory especially designed for the manufacture of these products. This factory will be completed and the wheels turning in it by about Nov. 1, when the present plants of the Whitney Electrical Instrument Company and the Switchboard Equipment Company will be abandoned. The factory will cover about 15,000 sq. ft. on a plot of ground of about 2½ acres, thus allowing for ample extension.

MELLEN PROMISES TO BUILD NEW ELECTRIC LINE.—At the investigation by the Public Service Commission of the First District of New York into the general condition of the New York & Portchester Railroad Company and the New York, Westchester & Boston Railway Company, Mr. Charles S. Mellen, president of the New York, New Haven & Hartford Railroad, which owns both properties, asserted positively that construction would begin on one or the other of the lines just as soon as the litigation concerning the franchise had been cleared up. He said that in no case would the New Haven attempt to build both roads, but that if the court holds the Westchester franchise to be valid, that road will be built: if the Westchester franchise is worthless the Portchester road will be built. The New Haven will back the enterprise, although funds are to be raised by issuing securities on the road that is to be built. Mr. Mellen also created something of a sensation by asserting that if the New Haven railroad could not make satisfactory arrangements with the existing rapid transit lines for running its suburban trains to the southern end of Manhattan, it might be necessary for it to ask permission to build a subway of its own from the Harlem River to the Battery. In answer to the question as to whether the New Haven would be interested in getting a subway of its own, Mr. Mellen said: "It would naturally prefer to use existing lines, but it must take care of the commuter business, and if it cannot use existing lines, it must do the next best thing." Mr. Mellen said that the Westchester and Portchester properties as they stand to-day had cost the New Haven railroad about $11,000,000—"some of which is wind and water, and some substance."

MEXICAN PUMPING PLANT.—The Compañia Azucarera del Panuco has just purchased for its sugar plantation, at "El Higo," some 200 km up the Panuco River, above Tampico, a gas plant to pump water for irrigating purposes. This outfit, purchased through Messrs. G. & O. Braniff & Company, representatives of the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., and the Westinghouse Machine Company, consists of a Westinghouse suction gas producer, to operate on charcoal or anthracite coal, having a capacity of 150 hp and a Westinghouse three-cylinder, 15 x 14 gas engine of 140 hp capacity, of the belted type, running at 260 r.p.m. This engine is to be complete, with connections to producer, and has the usual air-starting outfit, etc., and will drive, by means of a belt, an "Enke" centrifugal pump, having a capacity of 285 liters per second (about 4500 gal. per minute), against an approximate head of 25 m. The water will be delivered to the cane fields, some 625 m distant, by means of steel pipe, and into a canal feeding different sections of the ground to be irrigated. This is another example of the advantages of gas engines for cheap irrigation, and the benefits can readily be calculated when it is estimated that with the pumping plant referred to, 50 per cent more cane will be gathered by watering the land than could be done without irrigation.

LARGE ORDERS FOR PRESCOTT, ARIZ., HYDRO-ELECTRIC PLANT.—The Electric Operating Construction Company, 49 Wall Street, New York, has placed orders for the 6000-hp plant of the Arizona Power Company, at Prescott, Ariz., as follows: To the General Electric Company, for 6000 hp of generators and transformers. To the Waclark Company, for 200 miles of No. 1 and 250 miles of No. 4 copper wire. To the U. S. Wind Engine & Pump Company, of Batavia, Ill., for transmission towers. For water wheels, to the Abner Doble Company, of San Francisco. For siphon pipe to the William B. Pollock Company, of Youngstown, Ohio. The penstock will be furnished by the Pelton Water Wheel Company, New York and San Francisco. The insulators will be furnished by the Lime Insulator Co., of Lima, N. Y.

CAR EQUIPMENT ORDERS FOR GENERAL ELECTRIC.—The General Electric Company has been awarded the contract for equipping the 18 new cars recently purchased by the Westchester Electric Railroad Company, and the 15 cars bought by the Yonkers Railroad Company. The two orders amount to 56 65-hp motors and for all other necessary car equipment. Officials of the General Electric report that business is somewhat improved and the tone of the inquiries received is much better. The best showing is being made by the smaller merchandising lines, business in large apparatus in many instances being held up pending bond issues. The plants of the company are now working fuller time than at any period since the depression began.

MILL POWER PLANT.—The power station for the new mill of the Warrenton Woolen Company, Torrington, Conn., which is being erected and equipped in accordance with plans and specifications of Chas. T. Main, engineer, Boston, is isolated from the main body of the mill, which is to be operated with electric power. The building is 73 ft. x 52 ft., with chimney 125 ft. high; the boiler house is about 40 ft. x 50 ft., and the engine house about 30 ft. x 40 ft. The building is of brick with steel trusses and reinforced concrete roof. An industrial railway runs from the coal pocket to the boiler house.

WORK BEGUN AT HAUSER LAKE, MONT.—Construction forces of the Stone & Webster Engineering Corporation are clearing the site of the Hauser Lake dam preparatory to the work of erecting a new structure. A contract was signed with the Missouri River Power Company on July 11. It provides for the construction of a dam at Hauser Lake, together with a second dam and power plant of 30,000 hp at Wolf Creek on the Missouri River, a few miles below Hauser Lake. Both plants will supply Helena and Butte, Mont.

NEW TRACTION LINES IN CONNECTICUT.—The Connecticut Company, which is the New York, New Haven & Hartford Railroad Company's trolley holding corporation, has awarded contracts for new lines from Hartford to Bloomfield and from Willimantic to South Coventry, 12 miles in all. This line will cost $500,000. Another contract has been made for a line from Middletown to Wethersfield, a distance of 11 miles, the cost of which will be $400,000.

LOCAL AGENTS FOR THE JUST TUNGSTEN LAMP.—The Electrical Accessaries Company, 1135 Broadway, New York, the American agent for the Just tungsten lamp, is now prepared to appoint local agents of the Just tungsten lamp in all cities where not yet represented. Mr. J. Auerbach, president of the company, has just returned from a visit to the European factory, and has arranged for regular large shipments of the lamp, of which about 100,000 of different candle-power and voltage are now carried in stock for immediate delivery.

Financial Intelligence.

THE WEEK IN WALL STREET.

When the Wall Street stock market seemed buoyant and strong and continued to advance during the recent bull movement, the ordinary traders were continually asking each other: "What's the reason?" There was no political reason in sight, there was no crop news to warrant a boom, there was no sudden betterment in general commercial conditions and money

was no more plentiful and little cheaper than it had been for months. That the market was being pushed up by strong hands, everyone felt confident, but as there seemed to be no particular pool behind any particular stock, there was more vagueness and uncertainty about the campaign than is customary in the usually very well-informed Wall Street. The check in the upward movement was not so hard to understand. With trade conditions moving back toward the normal with such tedious deliberation, only manipulation of the most artificial kind could keep up the advance in stocks without periods of reaction. The advance of from 5 to 10 points in most of the active stocks within a fortnight would inevitably tempt the majority of dealers to take in profits. This is what occurred about the middle of the second week of August and, while the interests who were back of the advance attempted to stem the tide and hold to the advantage gained, the pressure became too heavy and the reaction within the past week has been general. The whole trend of the market, however, is toward a higher level and, like the other advances and reactions which have marked the course of stocks since the better days began in May, the backward swing is never quite as great as the forward swing and there is always a little net gain to be chronicled. Each upward swing has made a new high record for the year, none of the downward courses has gone as low as the one immediately preceding it. In the latest reaction American Smelting led the procession and for the week ended Aug. 15 recorded a net loss of 11⅛ points. This was, of course, not unexpected on account of the activity of the issue and also from the fact that in the advance this stock had shown most prominently. When the market firmed up a bit on Monday, Aug. 17, Smelting was again the strongest on the list and gained 3⅝ points. There is no stock on the list so easily influenced by the ordinary rumors that are called "market news"; there is none where the uncertainty of real conditions makes manipulation so easy. The news developments of the week of reaction, while not of any great magnitude, were all practically of a favorable nature. The outlook for the crops continues to be encouraging and the return to business prosperity is surely, if slowly, approaching. The iron and steel trades are showing gradual improvement, more employees are being put to work, more buyers are in the market looking for goods, and there is an air of cheerfulness and hope prevailing in all commercial circles. Even the railroads are taking a less gloomy view of life and, while earnings are still far below those of last year and the improvement is coming very slowly, there is a marked decrease in the number of idle cars. The report of the car service committee for Aug. 5 gave the total number of idle cars as 281,621, a decrease of 27,059 from the previous figures given out July 22, and a decrease of 131,984 from the high-water mark of April 29. The crop movement has begun to some extent, but it is not yet of sufficient proportions to cause any material growth of traffic, and the most even-minded railroad officials do not anticipate any very important improvement until October or November. As has been pointed out before, politics no longer seems to be a factor in Wall Street. There is no discussion on the subject. Mr. Bryan's speech of acceptance, while much more conservative than had been expected, in reality caused not a ripple. Since the nomination of Mr. Taft there has apparently been no uneasiness on the score of the Presidential campaign. The money market remains easy, the demand being much below the supply. Quotations on Aug. 17 were 1 to 1¼ for call and 2½ to 3 for 90 days. The closing quotations in the table are of Aug. 17.

NEW YORK.

	Aug. 10.	Aug. 17.	Shares Sold.		Aug. 10.	Aug. 17.	Shares Sold.
All.-Ch.	11⅜	11⅜	2,280	Int. Met., pfd	37	33½	32,245
All. Ch., pfd...	35¼	35¼	10,100	Mackay Cos....	69½	68	300
Amal. Cop.....	82⅞	77¼	260,210	Mackay Cos., pfd.	69	68⅜	400
Am. D. T.....	39*	39*	———	Manhattan Elev.	—	138*	2,535
Am. Loc.....	58	56	35,745	Met. St. Ry....	40½	38*	1,600
Am. Loc., pfd..109		107*	200	N.Y.&N.J.Tel.	114½	110⅛	———
Am. Tel & Cbl.	64½*	64½*	———	Steel, com.....	48	45⅜	498,490
Am. T. & T....122		123½	17,200	Steel, pfd.....110¼		108⅞	40,942
B. R. T.....	56¾	53	110,560	W. U. T.....	57¾	56½*	1,350
Gen. Elec.....146½		142	2,200	West'h, com...	76	68½	10,420
Int. Met., com.	13⅛	11⅞	300	West'h, pfd....	95	92*	350

PHILADELPHIA.

	Aug. 10.	Aug. 17.	Shares Sold.		Aug. 10.	Aug. 17.	Shares Sold.
Am. Rys.....	45	46	———	Phila. Elec.....	10	9⅞	———
Elec. Co. of A..	10⅛	10	———	Phila. R. T.....	14¾	13½	———
Elec. Stor. B'ty.	39¼	38	———	Phila. Traction.	89	89	———
E. S. B'ty, pfd..49		49*	———				

CHICAGO.

	Aug. 10.	Aug. 17.	Shares Sold.		Aug. 10.	Aug. 17.	Shares Sold.
Chi. City Ry...176½		176½*	———	Met. El., com...	15	15	———
Com. Edison....101¾		104¼	———	Met. El., pfd...	47½	45	———
Chi. Subway....	23	21½	———	Nat'nal Carbon.	70*	72½	———
Chi. Tel. Co....143		145⅛	———	Nat. Carb., pfd.109		108½	———

BOSTON.

	Aug. 10.	Aug. 17.	Shares Sold.		Aug. 10.	Aug. 17.	Shares Sold.
Am. Tel & Tel..122¼		123½	———	Mass. E. R., pfd.	49*	49*	———
Comb'ind Tel...	—	115½	———	Mex. Tel., pfd..	6*	6*	———
Gen. Elec.....145⅛		143	———	N. E. Tel'p.....103		113	———
Edison El. Ill..214½		—	———	W. Tel. & Tel..	6*	6*	———
Mass. Elec. Ry..	10¼	10½	———	W. T. & T., pfd.	70	72	———

*Last price quoted.
Shares sold are for week Aug. 10 to Aug. 15.

DIVIDENDS.

American Telegraph & Cable Company, quarterly, 1¼ per cent, payable Sept. 1.

Columbus (Ohio) Railway Company, common, quarterly, 1¼ per cent, payable Sept. 1.

Grand Rapids Railway Company, common, quarterly, 1 per cent, payable Sept. 1.

Whatcom County Railway & Light Company, preferred, semi-annual, 3 per cent, payable Sept. 1.

Northern Texas Electric Company, preferred, semi-annual, 3 per cent, payable Sept. 1.

POWER COMPANIES MERGED AT SPRINGFIELD, OHIO.—The Springfield Light, Heat & Power Company, of Springfield, Ohio, has been incorporated with a capital stock of $1,000,000 by J. D. Price, W. H. Sharp and L. M. Ferguson, of Columbus, Ohio, W. W. Keifer, F. M. Hagan and Charles S. Kay, of Springfield, and others. Mr. Sharp was at the head of the Columbus Public Service Company which recently turned its properties over to another company to be leased to the Columbus Railway & Light Company and is well known in the lighting business. The purpose of the new company is to take over the properties of the People's Light, Heat & Power Company and the Home Lighting & Heating Company. The merger has been approved by the stockholders of the former company, but the Home Lighting & Heating Company has not taken action. Mr. E. S. Kelly, who controls the bulk of the stock, is said to have stated that the property is for sale at $450,000 to anyone who has the money to purchase it.

AMERICAN TELEPHONE CONVERTIBLES IN LONDON.—The London Stock Exchange has listed the $100,000,000 American Telephone & Telegraph Company convertible 4 per cent bonds. The stock of the company was listed in London in October, 1907. Of the 220,000 shares offered to stockholders in June, 1907, about 30,000 shares were taken by English bankers, and it was in part to assist in the distribution of this stock that it was listed in London. In the same manner the listing of the bonds is a recognition of the English participation in the underwriting syndicate, about $25,000,000 of the bonds having been taken by the English bankers at the time of the sale of the bonds.

BRISTOL & PLAINVILLE TRAMWAY PROSPEROUS.—The directors of the Bristol & Plainville Tramway Company, of Bristol, Conn., have voted a 50 per cent stock dividend to the shareholders. This will increase the capital stock of the company from $250,000 to $375,000. The company was formed in 1895 as a consolidation of the existing electric light and tramway business of the town, and has been remarkably successful. When some outside parties tried unsuccessfully to buy the control of the company two years ago the leading stockholders got together and pooled their holdings for five years under trustees, and that has three years more to run. The president of the company is Miles Lewis Peck.

NEW YORK & NEW JERSEY TELEPHONE COMPANY.—The net earnings of the New York & New Jersey Telephone Company for the first six months of 1908 show an increase of $116,350 over the similar period of 1907, in spite of the fact that expenses increased $227,224 and fixed charges were $35,167 larger. This should be considered a most excellent showing in times of depression, and is undoubtedly satisfactory to shareholders. The increase in dividends was $65,493 and the surplus, after all payments, $307,816, a slight gain over the previous year.

PURCHASES PHILADELPHIA COMPANY'S NOTES.—The Mellon National Bank, of Pittsburg, has purchased $2,600,000 of the 6 per cent notes of the Philadelphia Company. They mature serially and are part of the $3,500,000 issue recently authorized. The Union Trust Company, of Pittsburg, is trustee of the issue to secure which there has been deposited collateral amounting to $6,325,000.

TELEPHONE EARNINGS SHOW SUBSTANTIAL GROWTH.—The statement of the earnings for the first six months of 1908 of the telephone operating companies of the American Telephone & Telegraph Company bear witness to the fact that the telephone business has made remarkable progress, even in times of depression. The gross revenue increased in the half year 6.4 per cent, and because of the proportionately lower operating expenses the net revenue was increased 7.5 per cent. In fact, the feature of the six months' statement is the reduction of the proportion of gross consumed by operating expenses exclusive of maintenance. The ratio was 45.1 per cent, whereas for the corresponding period of the previous year the figure was 46.8 per cent. This makes a reduction of 1.7 per cent points, resulting in a saving of gross earnings of over $1,000,000. Another notable element of the expense account is the larger sums charged to maintenance, a reflection of the management's policy in keeping the property well maintained. Maintenance consumed 28.8 per cent of gross up to June 30 this year, as compared with 27.2 per cent for the first six months of last year.

CONSOLIDATION OF TELEPHONE COMPANIES.—The American Union Telephone Company, with headquarters at Harrisburg, Pa., and the Consolidated Telephone Company, with headquarters at Allentown, both independents, have been merged by the former concern absorbing the latter. The Consolidated operates 47 exchanges in Lackawanna, Luzerne, Carbon, Northampton, Lehigh, Berks, Montgomery and Bucks County, and in addition some New Jersey territory between Belvidere and Trenton. The American Union operates independent lines throughout Pennsylvania as far west as McKeesport, north to Erie and east to near Philadelphia, also in portions of New York, New Jersey, Maryland, West Virginia and Delaware. It has 187 exchanges with a total of 51,000 telephones in service. President Ellis L. Orvis, of Bellefonte, and Vice-President F. D. Houck, of Harrisburg, of the American Union, were elected to like positions in the Consolidated. The capital of the American company is $25,000,000, while that of the company it absorbed was $4,000,000.

LOWELL & FITCHBURG BONDHOLDERS ORGANIZE.—The bondholders of the Lowell (Mass.) & Fitchburg Electric Company met in Lowell Aug. 14 and organized a protective committee to look after their interests. The committee is James W. Green, chairman, and C. F. Allen, of Gloversville, N. Y.; H. S. Scoffield, of Troy, N. Y.; W. H. Emhardt and Julius Christensen, of Philadelphia. The committee has formulated a bondholders' agreement to be accompanied by a deposit of the bonds, and authorizing the committee to levy an assessment on the bondholders of not to exceed 2 per cent of the face value of the bonds, to be used for the purpose of placing the road in position to become part of a through line between Lowell and Fitchburg, Mass. Holders of $450,000 of the total of $550,000 of bonds have signified their intention of becoming parties to the bondholders' agreement.

CAROLINA POWER & LIGHT COMPANY.—The capitalization of the Carolina Power & Light Company, the new corporation which has taken over the Raleigh Electric Company, of Raleigh, N. C., the Consumers' Light & Power Company, of Sanford, and the Central Carolina Power Company, of Buckhorn Falls, will be an authorized issue of preferred stock of $1,250,000 and of common $2,500,000. The president of the new corporation is Mr. Charles E. Johnson, of Raleigh. The company controls the street car and lighting system of Raleigh and the power systems of Raleigh, Fayetteville and Sanford. From the plant at Buckhorn Falls power is now transmitted to Fayetteville and it is now proposed to bring this to Raleigh.

UTILITIES COMPANY FOR NORTHERN INDIANA AND OHIO.—Articles of incorporation have been filed at Indianapolis for a public utilities company, with a capital of $4,500,000, the purpose of which is to furnish light, heat and power, by means of "gas, electricity, steam and hot water" to a score of towns in Northern Indiana and Ohio. The home office of the new company is at Lafayette, Ind. The directors, most of whom are known in the gas and electrical world, are: Franklin L. Babcock, Anthony N. Brady, Charles F. Dieterich, Frank S. Hastings, of New York; James P. Lee, Samuel T. Murdock, Henry C. Paul, Albert Tag and James N. Wallace, of Indiana.

RIVAL TO NORTH AMERICAN COMPANY.—News received from Milwaukee, Wis., says that the electric railway interests are not to be consolidated. The Eastern Wisconsin Electric Railway & Light Company and the Winnebago Traction Company, it is said, will form the nucleus of a new organization which will be a rival of the North American Company.

REPORTS OF EARNINGS.

	Gross Earnings.	Operating Expenses.	Net Earnings.	Charges.	Surplus.
New Orleans Railway & Light Company:					
Jan. 1 to June 30, 1908	$3,054,535	$1,714,429	$1,340,106	$991,521	$348,585
Jan. 1 to June 30, 1907	3,066,155	1,577,171	1,488,984	972,287	516,697
United States Telephone Company:					
Year 1907	435,013	184,135	250,878	116,877	168,966
Year 1906	402,052	159,414	242,638	121,342	139,398
Cumberland Telephone & Telegraph Company:					
July, 1908	500,094	283,473	216,621	37,347	179,274
July, 1907	474,851	306,020	168,831	36,522	132,309
Crosstown Street Railway Company, Buffalo:					
April 1 to June 30, 1908	158,095	93,896	64,199	49,371	16,133
April 1 to June 30, 1907	168,313	109,590	58,723	50,143	9,852
International Railway Company, Buffalo:					
Jan. 1 to June 30, 1908	1,084,540	568,797	525,743	284,537	159,052
Jan. 1 to June 30, 1907	1,115,005	742,081	372,923	252,937	137,442
American Telephone & Telegraph Company:					
June, 1908	10,012,700	7,388,300	2,624,400	.....	2,431,500
June, 1907	9,467,200	6,889,300	2,577,900	.....	2,355,100
Rutland (Vt.) Railway, Light & Power Company:					
Year to June 30, 1908	254,807	140,444	114,362	75,000	39,362
Year to June 30, 1907	229,409	132,930	96,479	75,000	21,479
Kansas City Railway & Light Company:					
June, 1908	515,441	298,735	216,606	155,381	61,288
June, 1907	115,816	281,275	234,541	153,228	81,313
Schuylkill Railway Company, Girardsville, Pa.:					
Year ending June 30, 1908	206,479	104,299	102,179	68,500	33,697
Year ending June 30, 1907	202,262	105,973	96,289	68,402	27,887
New York & New Jersey Telephone Company:					
Jan. 1 to June 30, 1908	4,514,512	3,245,354	1,269,158	78,117	1,191,041
Jan. 1 to June 30, 1907	4,170,938	3,018,130	1,152,808	42,950	1,109,858
Rochester (N. Y.) Railway Company:					
April 1 to June 30, 1908	659,094	435,528	223,565	122,490	102,082
April 1 to June 30, 1907	642,659	385,554	257,105	146,431	111,012
Syracuse (N. Y.) Rapid Transit Company:					
April 1 to June 30, 1908	321,736	184,168	137,568	103,937	34,743
April 1 to June 30, 1907	304,027	180,809	123,217	93,681	29,828

GENERAL NEWS

Construction News.

ALBERTVILLE, ALA.—The Sand Mountain Electric Company contemplates installing an electric plant and the erection of three and one-half miles of transmission lines to furnish electricity for lighting the town of Albertville. The company is in the market for a new or second-hand equipment for an electric plant, including a 75-kw, three-phase, 60-cycle alternator (belted) and accessories.

GURLEY, ALA.—Fred A. Howe, of Huntsville, Ala., has been granted a franchise to establish and operate an electric light plant in Gurley.

FLORENCE, ARIZ.—The Copper Creek Company is making arrangements to install a 500-hp electric plant to operate the hoists and pumping machinery in its mines.

BATESVILLE, ARK.—Plans are being considered by J. I. Woodfill and A. Webber to develop water power at lock and dam No. 1, about one mile from Batesville, where a minimum of 5000 hp and a maximum of 10,000 hp can be secured. The power will be used to generate electricity, which will be distributed in Batesville and adjacent towns. It is proposed to organize a company under the name of the White River Power Company to operate the plant.

FORREST CITY, ARK.—The citizens have voted to issue $30,000 in bonds, the proceeds to be used to consolidate and improve the municipal electric light plant and water works system.

LITTLE ROCK, ARK.—Extensive improvements are being made to the power house of the Little Rock Railway & Electric Company, including the installation of a 1500-kw steam turbine purchased from the General Electric Company. D. A. Hegarty is general manager.

WYNNE, ARK.—The plant and holdings of the Wynne Telephone Company have been taken over by the Going Telephone Company, the consideration being $7,500. The new owners will make extensive improvements to the system.

NEVADA CITY, CAL.—It is reported that William B. Bourn contemplates building a dam on the Yuba River and will also raise the present dam at Bowman to 65 ft. It is said that the company will furnish water and power to operate the mines in this vicinity.

RED BLUFF, CAL.—The Northern Electric Company has applied to the City Trustees for a franchise to construct and operate an electric railway in this city and claims it will build an electric railway from Chico to connect with Red Bluff within one year.

RED BLUFF, CAL.—B. Cusick, of Chico, has filed a notice of appropriation of 8000 in. of water in Deer Creek, to be used for generating electricity. A claim has also been filed by W. C. Smith for 8000 in. of water in the same creek.

REDLANDS, CAL.—The directors of the Redlands & Yucaipa Electric Railway are making arrangements to commence work on the construction of the road in the near future. It is proposed to build the Redlands portion of the railway and the Mile High extension as soon as possible, in order to have railway completed before the opening of the Mile High Hotel and resort next summer.

REDWOOD CITY, CAL.—S. M. Snyder, of North Fair Oaks, has presented a petition to the Town Trustees for a franchise to construct and operate an electric railway in the town.

RICHMOND, CAL.—The Board of Trustees has granted the East Shore & Suburban Railway Company a franchise to construct and operate an electric railway on San Pablo Avenue.

WILMINGTON, CAL.—The Board of Trustees has granted a franchise to the Pacific Electric Railway to build an electric railway to Long Beach.

WOODLAND, CAL.—The fire and water committee has been instructed to make an investigation as to the cost of installing an auxiliary pumping plant to be operated by a 75-hp motor and report as soon as practicable.

COLORADO SPRINGS, COL.—A resolution has been introduced in the City Council recommending that the city take steps at once to secure the water rights granted to Irving Howber and associates to generate electricity to operate a Colorado Springs-Cripple Creek electric railway, claiming that their successors had failed to keep the terms of the franchise. This is the first step toward establishing a municipal lighting plant.

CRESTED BUTTE, COL.—The Crested Butte Telephone Company is considering the question of erecting a telephone line to Aspen.

DANBURY, CONN.—The Danbury Agriculture Society has awarded a contract to the Fairbanks-Morse Company, of New York, N. Y., to install an electric light plant at the Danbury Fair Grounds to furnish electricity for 250 lamps. The equipment of the plant will include a 25-hp gasoline engine with dynamo, which will be located on the north side of the grounds near the present boiler house. The plant will also furnish electricity for motors for the exhibits about the grounds and buildings and will be ready for operation in time for the annual fair in October.

HARTFORD, CONN.—Plans are being drawn for the construction of a new factory building for the Terry Steam Turbine Company on Windsor Street extension. A power plant will also be erected.

NEW HAVEN, CONN.—The Connecticut Company, the holding company for the New York, New Haven & Hartford Railroad Company's public service utilities in Connecticut, has awarded contracts to Lathrop & Shea, of New York City, N. Y., for the construction of an electric railway from Hartford to Bloomfield, Conn., and from Willimantic to Coventry, Conn., 12 miles in all, for $500,000.

PUTNAM, CONN.—The contract for lighting the streets of the city has been awarded to the Putnam Light & Power Company. The contract is for one year from June 1, 1908, under the terms of which the city will pay $81.70 for each arc lamp per year, and $16.34 for each incandescent lamp.

WASHINGTON, D. C.—The contract for furnishing electric lighting fixtures for the new Senate office building has been awarded by Elliott Woods, superintendent of the U. S. Capitol Building and Grounds, to the Mitchell Vance Company, of New York, N. Y., for $35,521.

WASHINGTON, D. C.—The Commissioners of the District of Columbia have accepted the recommendation of the electrical engineer to accept the proposition of the Potomac Electric Power Company to furnish electricity for street lighting at the rate of $85 per lamp per year.

WASHINGTON, D. C.—Bids will be received until Aug. 31 by Bernard R. Green, superintendent of construction of building for National Museum, Library of Congress, Washington, D. C., for furnishing, delivering and installing in place complete the electric wiring required for the south pavilion of the new building for the National Museum at Washington.

ATHENS, GA.—The Athens Electric Railway will increase the output of its power plant by 1000 hp. The present plant generates 3000 hp.

HONOLULU, HAWAII.—The Honolulu Rapid Transit & Land Development Company contemplates extending its railway system from Honolulu to Pearl Island, a distance of 12 miles, in the near future.

ELK CITY, IDAHO,—A movement has been started among the mining men of Central Idaho districts, backed by Spokane and Eastern capital, for the construction of an electric railway from Orogrande and Elk City, thence to Camas Prairie, and from there to connect with a line to Lewiston. The new railway will be known as the Elk City, Lewiston & Spokane Electric Railway. Capital stock to the amount of $200,000 has been subscribed at the Elk City end of the railway.

CENTRALIA, ILL.—The plant and holdings of the Centralia Gas & Electric Company have been purchased by H. C. Higgins, formerly of Dixon, Ill. A. L. Gillette is general manager.

CHICAGO, ILL.—The new schedule of rates for electricity furnished by the Commonwealth Edison Company went into effect Aug. 1. The cost of electricity for lamps will be reduced 13½ per cent. Under the new schedule the maximum price is 12 cents per kw-hour and the minimum 7 cents per kw-hour, allowing 1 per cent discount per kw-hour for payment of bills within 10 days. The old rate was 14 and 8 cents.

PERU, ILL.—G. C. Miller, of Chicago, electrical engineer, having made a thorough examination of the municipal electric light plant, recommends changing the system from direct to alternating current. The plant is overloaded.

EVANSVILLE, IND.—C. E. Teush, 1400 Gum Street, Indianapolis, Ind., is in the market for equipment and supplies for a complete telephone system. He wishes catalogs and printed matter of supplies with prices.

FORT WAYNE, IND.—Plans are being prepared by W. A. Hopkins, electrical engineer, for the Wabash Railroad Company for equipping the shops at Fort Wayne, Ind., to be operated by electricity, also for lighting the buildings and grounds by electricity. The company has installed storage batteries on all its sleeping cars west of the river and will light its cars by electricity.

GOSHEN, IND.—The City Council has taken steps toward the installation of a municipal electric lighting plant and a new water works station.

COUNCIL BLUFFS, IA.—A company has been organized, with a capital stock of $1,000,000, to construct a railway between Des Moines and Council Bluffs. The Metropolitan Trust Company, of Chicago, Ill., is said to be in charge of the financial end of the project. Surveys of the route have been completed, and it is proposed to use gasoline or storage battery motor cars for passenger service and steam for freight cars.

LANSING, IA.—Dolphin & Olson, owners of the Lansing electric light plant, contemplate installing a 300-light storage battery in their plant.

SIOUX CITY, IA.—At an election held Aug. 11 the citizens voted to grant the Sioux City Traction Company a franchise to extend its railway system through certain streets of the city and to extend the time of some of its older franchises.

LAWRENCE, KAN.—Application has been made to the city council by C. E. Sutton, W. E. Spaulding, William Bromelsick, C. H. Tucker and J. E. Stubbs for a franchise to operate an electric railway in this city. It is proposed to organize a company to be capitalized at $250,000 to construct and operate the system.

SENECA, KAN.—Plans are being considered to install a new engine, dynamo and switchboard in the municipal electric light plant, and to change the primary voltage to 2200. The transmission lines will also be overhauled. G. D. Myers is manager.

LEXINGTON, KY.—The Lexington & Interurban Railways Company is planning to erect a large power house to cost between $450,000 and $500,000. The General Electric Company, of Schenectady, N. Y., will furnish the electrical equipment.

MAYFIELD, KY.—The Mayfield Water & Light Company has awarded the contract for construction of its power house to the Weidenfeller Construction Company, of Chicago, Ill. The machinery has already been purchased, including electric generator and water pumps, at a cost of about $60,000. The electric plant will have an output of about 1000 kw. The former plant was recently destroyed by fire.

PINEVILLE, KY.—A plan is under way for the construction of an electric railway from Pineville to Straight Creek, a distance of about nine miles. N. R. Patterson, W. Burchfield and B. R. Smith, all of Pineville, are interested in the enterprise.

WINFIELD, LA.—Arrangements are being made to enlarge the electric lighting system in Winfield.

BAR HARBOR, MAINE.—The local plant of the Bar Harbor & Union River Power Company is being operated by electrical energy from the Ellsworth hydro-electric plant. The steam plant will be held in reserve for emergencies. The present plan is to extend the transmission line from Ellsworth to Bangor, and also to Veazie. Luther E. Beach is superintendent of the Bar Harbor plant.

BIDDEFORD, MAINE.—A 600-hp engine in the plant of the York Light & Heat Company was badly damaged by the blowing out of two cylinder heads, causing a loss of about $5,000. The engine will be out of commission the rest of the summer.

BALTIMORE, MD.—Owing to the objection of property owners to placing arc lamp-posts opposite their premises Superintendent of Lamps and Lighting McCuen is considering the advisibility of experimenting with the tower system of street illumination in Baltimore.

AMESBURY, MASS.—The Hamilton Company has installed an electric light plant to furnish electricity to light its mills. The company has decided to make connections with the local electric company so as to secure its services in case of emergencies.

BOSTON, MASS.—The Charlestown Gas & Electric Company has reduced the price of electricity for lamps from 15 cents to 12 cents per kw-hour.

BROCKTON, MASS.—The Edison Electric Illuminating Company, of Brockton, is extending its transmission lines into Norwell by the way of River Street and the Corners.

CLINTON, MASS.—The Massachusetts Lighting Corporation, owner of the Clinton Gas Company, of Clinton, has notified the Board of Selectmen that the company is willing to sell its gas and electric plants to the town.

DANVERS, MASS.—The Electric Commissioners have placed a contract with Rice & Sargent Company, of Providence, R. I., for a new Corliss engine of 300 hp for the municipal electric light plant.

GRAFTON, MASS.—Arrangements are being made by the Grafton Electric Company to extend its transmission lines to Sutton to furnish electricity to light the streets of Sutton Center and West Sutton. The company was recently awarded a contract by the Selectmen of Sutton by which it is to furnish not less than 65 incandescent lamps for a term of five years at the rate of $14 per lamp per year, the lamps to be ready for use by Oct. 1, 1908.

METHUEN, MASS.—The citizens have voted to instruct the Selectmen to enter into a contract with the Lawrence Gas Company, of Lawrence, Mass., for lighting the streets of the city for a term of five years. Under the terms of the contract the company is to replace the present street lamps with tungsten lamps of 40 cp, for which the city is to pay $17 per lamp per year. The town is now paying $70 per year for each arc lamp. About 240 new lamps will be installed, and it is said that the city will save about $1,000 a year under the new contract.

MILFORD, MASS.—The Milford Electric Light & Power Company has applied to the State Board of Gas and Electric Light Commissioners for permission to issue $40,000 in bonds, the proceeds to be used to reduce the floating debt of the company and to pay for contemplated improvements.

NORTH ADAMS, MASS.—A 500-hp Fitchburg engine in the electrical plant of the North Adams Gas Light Company was destroyed recently by the bursting of a flywheel, causing a loss of $10,000. Frank S. Richardson is treasurer and manager.

SHELBURNE FALLS, MASS.—The Shelburne Falls Electric Light & Power Company will erect a new power house here and install a 125-hp gas producer engine. It is said that the present power station, which is operated by water power, will be abandoned. When the new plant is completed the company will establish a 24-hour service.

SOUTHVILLE, MASS.—Poles are being erected in Southville for transmission lines for the distribution of electricity to light the streets of the village. It is said that electrical energy for operating the system will be furnished from the plant in Marlboro, and the transmission lines are to extend from Southville to Cordaville, with a local service in each village.

SPENCER, MASS.—E. E. Stone & Company are making arrangements to install a 25-hp turbine engine and dynamo in its plant and will furnish electricity for incandescent lamps to stores and business places in the vicinity of their shop.

SPENCER, MASS.—The Spencer Gas Company has petitioned the State Board of Gas and Electric Light Commissioners for authority to issue new capital stock to the amount of $55,000 and $85,000 in bonds, of which $59,500 of the proceeds of the bond issue is to be used to cancel a previous bond issue of that amount and the balance to be used to pay off the floating indebtedness.

WINCHENDON, MASS.—The contract for the new raceway at Centerville has been awarded to Nelson A. Hanks & Sons for $5,000. The raceway will furnish power for operating an auxiliary electric light plant, which is controlled by the Winchendon Electric Light & Power Company. The chair plant of Clark & Beals in Centerville was purchased about a year ago by William M. Whitney, president of the electric light company, which will be closed down shortly and converted into an auxiliary for the lighting plant.

WOBURN, MASS.—The Edison Electric Illuminating Company is making arrangements to furnish the town with electricity for lamps and motors from its L Street station in South Boston. The company is installing three 200-kw air-cooled transformers and three 100-kw oil transformers in the local power plant. The old plant will be held in reserve for emergencies.

KALAMAZOO, MICH.—The Citizens' Telephone Company has applied to the City Council for permission to establish a telephone system in Kalamazoo.

LARIUM, MICH.—The City Council has passed an ordinance requiring all wires to be placed underground in the business section of the city.

MUSKEGON, MICH.—The Citizens' Telephone Company has been granted permission to install a conduit system in this city.

SPARTA, MICH.—The citizens on Aug. 6 voted to issue $20,000 in bonds for the construction of an electric light plant. E. G. Anderson is village clerk.

BRAINERD, MINN.—Bids will be received by H. J. Spencer, city clerk, until Aug. 27 for the construction of power station, dam and hydro-electric plant; for steam gas-producer and oil electric plants; for substation and power pumping plant; steel standpipe, etc., f. o. b. Brainerd; and for any and all parts of the work complete, according to plans and specifications now on file at the office of the city clerk, Brainerd, and at the office of George Cadogan Morgan, 8008 Royal Insurance Building, Chicago, Ill., consulting engineer.

OSAKIS, MINN.—The Osakis Milling Company contemplates making improvements to its electric light plant and pumping station.

WORTHINGTON, MINN.—The City Council contemplates purchasing a new generator for the municipal electric light plant.

CLARKSDALE, MISS.—Bids will be received by the Mayor and Aldermen for constructing a 250,000-gal. roofed reservoir; reinforced concrete chimney; a 300-kw, three-phase engine type generator, and a 450-hp Corliss or four-valve engine to operate generator. Plans and specifications can be secured of Walter G. Kirkpatrick, Jackson, Miss., engineer.

POPLARVILLE, MISS.—The citizens have voted to issue an additional $10,000 in bonds, the proceeds to be used to extend the water and electric light plants. The city voted in May to issue $10,000 in bonds to extend the above plants. H. W. Thomas is engineer in charge of the work.

FARMINGTON, MO.—Owing to the authorization of a municipal electric light plant, which is now under construction, the Farmington Electric Light & Ice Company has discontinued its electric lighting business. Gustavus Sessinghaus is owner and manager.

KANSAS CITY, MO.—The Blue Ridge Merchants' and Manufacturers' Association has petitioned the City Council to pass the franchise ordinance permitting William F. Lyons to supply electricity for lamps in the eastern part of the city. The matter was referred to the Public Utilities Commission.

ST. JOSEPH, MO.—At a special election held Aug. 8 the citizens voted to issue $400,000 in bonds, of which the proceeds of $15,000 will be used for laying conduits and extending the "Whiteway," bids for which will be received until Aug. 29. David Lawler has charge of the work.

ST. LOUIS, MO.—A plan to establish a power plant on a portion of the property acquired by the city for municipal buildings at Thirteenth and Market Streets to furnish electricity and heat for city buildings, including fire engine houses east of Jefferson Avenue, has met the approval of the Mayor and will soon assume definite shape. The improvement will cost $100,000, of which $20,000 will be used in the erection of a building. If it is decided to build a new plant the equipment of the electric plant in the city hall will be transferred to the Insane Asylum.

BILLINGS, MONT.—The franchise for an electric railway, owned by Yegen Brothers, has been purchased by N. S. Poole, of Townsend, Mont.

The new owner, it is said, will build and operate a local street railway system and extend the railway up the valley. It is understood that work will begin on construction of the system before the end of the month.

DILLON, MONT.—We are informed that the organization of the consolidation of the Dillon Light & Power Company and the Greater Electric Company was completed July 2 after a competition of four and one-half years. The company does not contemplate any extensive improvements this year. L. K. Adams is manager.

McCOOK, NEB.—It is reported that the McCook Electric Light Company will erect an electric plant at a cost of about $35,000 as soon as a new lighting franchise is granted.

UNIVERSITY PLACE, NEB.—Plans are being considered by the Automatic Telephone Company for new equipment of the exchange at University Place which will involve an expenditure of about $5,000. The company contemplates building a trunk line to Bethany.

FRANKLIN, N. H.—The Franklin Electric Light & Power Company is extending its transmission lines to Webster Lake to furnish electricity to light the cottages at the lake.

LANCASTER, N. H.—The Lancaster & Jefferson Electric Company has leased the old saw mill property of Frank Smith Company, preparatory to an extension of its service.

RAYMOND, N. H.—The Raymond Electric Light Company is planning to install a 75-kw, three-phase generator and erect about six miles of transmission lines to the nearby towns. Charles F. Gardiner is owner.

HIGHTSTOWN, N. J.—Work has commenced on the new steam-heating plant for the Peddie Institute. The plant will include electric light and pumping equipment. The entire plant will cost about $18,000, for which contracts have been placed.

MORRISTOWN, N. J.—The Morris & Somerset Electric Company is preparing plans for an addition to its power house on Whipple Street, to install the additional machinery purchased to increase the output of the plant to meet the increased demands made upon the company since taking over the Public Service Corporation's plant. Two 250-kw generators and other machinery will be installed in the power house.

NEWARK, N. J.—The contract for the erection of the addition to the power plant at the penitentiary has been awarded to Storms & Company, of Newark, N. J., for $13,454.

NEWARK, N. J.—Contracts for installing the electrical plant at the Essex County Jail have been awarded as follows: To Paul H. Jaehnig, for engines and generator, for $6,580, and to David Seymour & Company, for boilers and piping at $3,679.

ALAMOGORDO, N. M.—The Alamogordo Light & Power Company contemplates developing a water power of 1000 hp, about eight miles from the city. M. H. Fisher is owner and manager.

LAS CRUCES, N. M.—We are informed that the Las Cruces Electric Light & Ice Company expects to install a new 125-kw, three-phase alternator. B. L. Berkey is president and manager.

LIBERTY, N. M.—We are informed that Vida Weborg, of Liberty, would like to receive information pertaining to water power generator sets and electrical pumping plants for irrigating purposes.

ARCADE, N. Y.—Contracts have been awarded to the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., for electrical equipment, and to the Ridgway Dynamo & Engine Company, of Ridgway, Pa., for an engine for the municipal electric light plant. H. B. Sweet, of Utica, N. Y., is engineer.

BERGEN, N. Y.—The Public Service Commission has served an order on the Genesee County Electric Light, Power & Gas Company, of Batavia, requesting the company to answer within 10 days as to why the company has failed to carry out its contract with the village of Bergen to furnish electricity to light the streets and to operate the pumps at the pumping station. The streets of the village have been in darkness since early in March.

BUFFALO, N. Y.—J. J. O'Leary, president of the Buffalo Electric Construction Company has been engaged by the Board of Trustees to make plans and estimates for the proposed electric light plant for the city hall.

CAMDEN, N. Y.—The Camden Home Telephone Company contemplates extensions to its system, including the erection of telephone lines to Sylvan Beach and to Talberg.

COLDEN, N. Y.—The Boston Valley Telephone Company is planning to erect a telephone line between Colden and Greenwood.

LE ROY, N. Y.—The contract for lighting the streets of the town has not yet been awarded, as the Board of Light Commissioners and the LeRoy Hydraulic Electric Gas Company have been unable to come to terms. The commissioners do not want to make a contract for five years and the company is not willing to make an agreement for less time. The town now pays at the rate of $60 per arc lamp per year, the lamps to burn until 1 o'clock on a moonlight schedule, making the cost of 57 lamps $3,420 per year. The company has offered to furnish the lamps on an all-night moonlight schedule for $70 per lamp per year, and for every night and all night for $80 per lamp per year, on a five-year contract. Arrangements have been made for the present service to continue until the town and company come to an agreement.

PRINCETON, N. Y.—The Trustees of the Princeton University have awarded the contract for the electrical work for the biology and geology building, now under construction, to the W. B. Foster Electrical Company, of New York, N. Y., for $16,000.

ROCHESTER, N. Y.—The Board of Supervisors has decided not to establish electric lighting plants for the court house and armory. The Commissioner of Public Buildings has advised the board to accept the proposition submitted by the Rochester Railway & Light Company for lighting the buildings for a term of five years.

SARATOGA SPRINGS, N. Y.—The contract for lighting the streets of the village has been awarded to the Saratoga Gas, Electric Light & Power Company for a term of four years. Under the terms of the contract the company is to furnish arc lamps for $87.50 per lamp per year; incandescent electric lamps at $20 per lamp per year; gas lamps at $20 per lamp per year, and gas for lighting public buildings at $1.25 per 1000 cu. ft. It is said that a saving of over $3,000 for the four years will be made under the new contract, which will take effect Oct. 1.

WILLIAMSVILLE, N. Y.—The Public Service Commission has granted the Williamsville Electric Light & Power Company permission to construct and operate an electric plant under its franchise privileges in the village of Williamsville. It has also granted the company authority to issue $25,000 in capital stock, the proceeds to be used to acquire power house and equipment. The company applied for permission to issue $35,000 in capital stock.

BEAUFORT, N. C.—The Beaufort Hotel Company contemplates building an electric light plant in connection with its proposed hotel and will furnish the town with electricity for lamps and motors.

CHARLOTTE, N. C.—The Kesler Manufacturing Company, of Charlotte, has awarded the contract for machinery to operate its plant by electricity. About 250 hp will be required.

RALEIGH, N. C.—It is reported that the Martin Hosiery Mill will install electrical equipment to operate its knitting machines.

TROY, N. C.—The contract has been awarded for the construction of a dam on Little River, five miles from Troy, which will develop about 1500 hp for transmission by electricity, which will be used to operate the Smitherman Cotton Mills in Troy. S. J. Smitherman and J. C. Hurley are interested in the enterprise.

JAMESTOWN, N. D.—The Western Electric Company contemplates installing two 72 x 18-in. boilers in its plant. J. H. Canham is manager.

CAMDEN, OHIO.—The Camden Electric Light Company has secured the contract for lighting the streets of the village, and is now installing the system. The company will furnish incandescents of 100 cp at $20 per lamp per year. Charles S. Houston is owner.

VAN WERT, OHIO.—The electric light and steam-heating plants owned by the Gas & Electric Development Company, of Philadelphia, Pa., in Van Wert, have been sold to a new company recently formed under the name of the Van Wert Public Service Company. The new company is composed of E. E. Mandeville, J. M. Maury, R. J. Darrow and others, of Philadelphia, Pa., and Van Wert, Ohio. The new owners propose to extend and improve the plant.

OREGON CITY, ORE.—F. M. Swift, who is interested in a project to construct an electric railway from Oregon City into the Beaver Creek, Molalla and Willhot Springs sections of Clackmas County, has filed a notice of appropriation of water from the main channel of the Molalla River, to be diverted about three-quarters of a mile below a point where the north and south forks of the river come together. It is proposed to build a canal 25 ft. wide at the bottom, 33 ft. wide at the water surface and 8 ft. deep.

BUTLER, PA.—Plans are being considered by a syndicate of Pittsburg and Butler men for the construction of an interurban electric railway from Butler to Slippery Rock by the way of West Sunbury.

ELLWOOD CITY, PA.—The Ellwood Power Company contemplates rebuilding and increasing the capacity of its dam on the Connequenessing River, south of the city. The cost of the work is estimated at $25,000. G. E. Seiler is manager.

HAZLETON, PA.—The City Council has awarded a contract to the Consumers' Electric Light & Power Company for lighting the streets of the city for a term of 10 years. The present street lighting system of open arc lamps will be replaced by 150 Westinghouse 4-amp flaming arc lamps.

PHILADELPHIA, PA.—Plans have been drawn by John T. Windrim for the construction of a large central heating plant for the Girard Estate to supply the dwellings owned by the estate, of which there will be about 200, with electricity for lamps and with steam heat.

POTTSTOWN, PA.—The Town Council has entered into a contract with the Pottstown Light, Heat & Power Company for lighting the town for a term of five years. Under the terms of the contract the company is to replace the present street lighting system with Westinghouse metallic flame arc lamps and to furnish arc lamps at the rate of $70 per lamp yer pear and incandescent lamps at $25 each per year. Under the present contract which expires Jan. 1, 1909, the city pays $82.50 per arc lamp per year and $31.90 to $25 each for incandescent lamps. The company will also furnish electricity free of charge for lighting the police station, borough hall and fire houses and for the fire whistle, and also agrees to extend its service to Stowe and Glasgow and other points within the borough, which will require the erection of about four miles of transmission lines. The borough will save about $1,490 per year under the new contract.

SCRANTON, PA.—An ordinance has been introduced in the City Council prividing for placing all of the electric wires, with the exception of the trolley wires of the street railway company, underground.

SPARTANSBURG, S. C.—The Spartansburg Railway, Gas & Electric Company, recently purchased by Pittsburg interests connected with the Electric Manufacturing & Power Company, is making arrangements to operate its system with electrical energy purchased from the Electric Manufacturing & Power Company. The local steam plant will be dismantled.

HURON, S. D.—The Electric Company is planning to install an additional 60-cycle dynamo in its plant in the near future, making the entire equipment of the plant 60 cycles. E. I. Bowe is owner and manager.

WAHPETON, S. D.—The Council is considering the question of granting a franchise for the transmission of electricity in this city, generated at the hydro-electric plant at Fergus Falls, Minn.

ALAMO, TENN.—The Alamo Home Telephone Company is planning to erect a telephone line to Bells, and also to Crockett Mills, Johnson's Grove, Cross Roads, Foster, and throughout Crockett County.

MARYVILLE, TENN.—The Rockford Electric Company contemplates constructing a concrete dam at its power house on Little River. James L. Clark is manager.

BROWNSVILLE, TEX.—The Brownsville Telephone Company is in the market for telephone cables. B. G. Stegman, of Brownsville, Tex., is manager.

GAINESVILLE, TEX.—The Gainesville, Whitsboro & Sherman Electric Railway Company has filed a first mortgage to the American Trust & Savings Bank, of Chicago, Ill., to secure an issue of $1,000,000 in bonds. The company was incorporated to construct an electric railway from Gainesville to Sherman, Tex., a distance of 39 miles. John King, of Gainesville, is president.

MUD, TEX.—The County Commissioners have granted J. T. Maxey permission to erect a telephone line from Mud to Austin, a distance of 25 miles.

PORT ARTHUR, TEX.—The Port Arthur Water Company will install a 500-hp engine and generator at its electric light and power plant.

PRICE, UTAH.—The citizens are considering the question of establishing a municipal electric light plant, plans and estimates for which are now being prepared.

MONTPELIER, VT.—The Dornsife & Mighlierini Company, of Montpelier, has secured the contract for the construction of the dam and power house on the Winooski River for the Barre & Montpelier Traction & Power Company, work on which will begin at once. The work will include the construction of a concrete dam 18 ft. high, 145 ft. spillway and a 6-ft. penstock, 3000 ft. long, providing 60-ft. head and furnishing 1000 hp. An auxiliary steam plant will be installed. The plant will furnish electrical energy to operate the electric railway system of the company. The plant will cost from $75,000 to $100,000. I. M. Frost is general manager.

PORTSMOUTH, VA.—The Norfolk & Portsmouth Traction Company has informed the City Council that it will soon submit a new tentative franchise for its consideration, which will cover the electric lighting and electric railway systems in Portsmouth. The company is erecting a new substation at the foot of Middle Street, which with equipment will cost $80,000, and is also erecting three cables to transmit electricity from its large power plant at Brambleton at a cost of $60,000. John Blair McAfee is president.

WAYNESBORO, VA.—The South River Light & Power Company is planning to establish a day service Sept. 1. E. N. Quarles is president and manager.

CHEHALIS, WASH.—The Chehalis Light & Power Company is making arrangements to establish a day service and also extension of its transmission lines in different parts of the city. E. Riggs is manager.

PASCO, WASH.—It is reported that the electric light plant owned by the Northern Light & Power Company was recently destroyed by fire.

RIVERSIDE, WASH.—The Johnson Creek Telephone Company will extend its lines throughout the county.

SEATTLE, WASH.—The output of the municipal electric light plant is being increased by the installation of 8000 kw additional apparatus. Two new additional substations will be erected in Seattle, with 15,000-volt feeders. L. B. Young is superintendent.

FAIRMONT, W. Va.—Work has commenced on the extension of the Fairmont & Clarksburg Traction Company's system down Parks Avenue to the new fair grounds on the east side of the river.

BAYFIELD, WIS.—The Water and Light Commissioners are considering the question of installing new boilers and switchboard in the municipal electric light and water plant. F. M. Harrick, Jr., is manager.

CASHMERE, WIS.—A. J. Amos, town clerk, writes that it is proposed to construct a municipal electric light plant and water works system at a cost of about $11,500.

CASHTON, WIS.—The State Railroad Commission has refused the application of the village of Cashton for a certificate of convenience and necessity to enable it to build a municipal electric light plant. The commission states that the field is not large enough to support two lighting plants and if the village desires it can, in accordance with the provisions of the public utilities law, purchase the plant owned by the Cashton Light & Power Company.

CHILTON, WIS.—Arrangements are being made to construct a municipal electric light plant to cost about $18,000, for which bids for construction will be received about Sept. 1. Augustus Meyer, of Appleton, Wis., is engineer, and T. J. Glenn is chairman of electric light committee.

CUMBERLAND, WIS.—Oscar Claussen, of St. Paul, Minn., consulting engineer, is preparing plans for a municipal electric light plant, for which the citizens recently voted to issue $25,000 in bonds.

LA CROSSE, WIS.—The La Crosse Telephone Company contemplates an issue of $100,000 in bonds, the proceeds to be used for the proposed extension of its lines.

MILLTOWN, WIS.—The Milltown Mutual Telephone Company is in the market for telephone supplies, including galvanized iron wire, steel wire, insulated wire, insulators, etc. M. A. Paulson, Milltown, Wis., is manager.

MILWAUKEE, WIS.—The Milwaukee Light, Heat & Traction Company has closed contracts with the Southern Wisconsin Power Company whereby the latter company is to furnish 8000 hp from the new dam in the Wisconsin River at Kilbourn to operate the interurban electric railways of the Milwaukee Light, Heat & Traction Company. The plant when completed will furnish electricity within a radius of 150 miles of the plant. M. Swenson is president of the power company.

NEW LONDON, WIS.—The Electric Light and Water Commissioners have awarded contracts for equipment for the municipal electric light plant as follows: To the Allis-Chalmers Company, of Milwaukee, for a two-phase generator at $1,568, and a Corliss engine to the Nordberg Manufacturing Company, Milwaukee, for $1,655.

WATERLOO, WIS.—The citizens are contemplating building a new municipal electric light plant and repairing the transmission lines. Eugene Porter is manager.

WAUSAU, WIS.—The Knox Engineering Company, of Chicago, Ill., is preparing plans for the construction of a power plant for the Wausau Street Railway Company. The plant will cost between $80,000 and $100,000 and will be built under the supervision of the Knox Engineering Company. M. C. Erving is general manager of the street railway company.

HAMILTON, ONT., CAN.—Orders will soon be placed for the new electric pumps to be placed in the Beach pumping plant for the new sewage disposal works.

HAMILTON, ONT., CAN.—Mayor Stewart on Aug. 8 signed the contract with the Cataract Power Company, which was authorized by the Board of Aldermen in July. The Mayor had refused to sign the contract, but was ordered by the court to do so as a result of the mandamus proceeding begun by H. C. Beckett.

ST. CATHERINES, ONT., CAN.—The City Council has cancelled the franchise of the Falls Power Company and has adopted a recommendation to call for new tenders for street lighting until Aug. 22, the contract to take effect from Nov. 1, 1908. The City Council has decided to apply to the Hydro-Electric Power Commission for prices and information, etc., for electrical energy for lighting the city.

SAULT STE. MARIE, ONT., CAN.—Plans are being considered for the reconstruction of the power plant of the Togona Water & Light Company, which was destroyed by fire last May, in the near future. J. S. Wynn is acting manager.

TORONTO, ONT., CAN.—The Hydro-Electric Power Commission has awarded the contract for the construction of the electric transmission line to be built by the Ontario Government from Niagara Falls to St. Thomas and Toronto, to the McGuigan Construction Company, for $1,270,000. The total length of the line to St. Thomas on the west and to Toronto on the east is 293 miles. The aluminum cable is to be constructed at Shawinigan, Que., and the steel towers at Toronto. The Commission has the option of doubling the mileage at the same price.

BATTLEFORD, SASK., CAN.—Plans are being considered to make about two miles of extensions to the transmission lines of the municipal electric light plant. W. A. Raymond is secretary and treasurer.

New Industrial Companies.

THE UNITED STATES EQUIPMENT COMPANY, of Chicago, Ill., has been chartered, with a capital stock of $250,000, to do a general construction and contracting business. The office of the company is at 277 Dearborn Street, Chicago, Ill.

THE CARL H. PAGE COMPANY, of New York, N. Y., has been incorporated with a capital stock of $50,000 to manufacture motors, engines, spark plugs, etc., by Carl H. Page, Robert R. Montgomery, and Henry B. Leary, all of New York, N. Y.

THE J. G. BARR ELECTRIC & HEATING COMPANY, of Chicago, Ill., has been incorporated to manufacture electric motors and equipment. The company is capitalized at $10,000 and the incorporators are: Jesse G. Barr, A. B. Irwin and Frederick Merrill.

THE LAUREL ENGINEERING & CONSTRUCTION COMPANY, of Cincinnati, Ohio, has filed articles of incorporation, with a capital

stock of $80,000. The incorporators are: J. Stanley Evans, Thomas Evans, D. C. Keller, E. F. Clayton and R. G. Watkins.

THE SUBMARINE COMPANY, of Hoboken, N. J., has been incorporated, with a capital stock of $75,000, by B. S. Mantz, John R. Turner and Robert R. Thiem, of Jersey City, N. J. The company proposes to do a general engineering and contracting business.

THE NATIONAL ELECTRIC COMPANY, of St. Louis, Mo., has filed articles of incorporation with a capital stock of $10,000. The incorporators are Robert C. Carr, Roland H. Robinson and Linton Robinson. The company will do general electric construction work.

THE J. H. LEHMAN MANUFACTURING COMPANY, of New York, N. Y., has been chartered with a capital stock of $25,000 by P. H. J. Daly, of Brooklyn; G. W. Anderson and J. H. Lehman, of New York, N. Y. The company proposes to manufacture mechanical and electrical appliances.

THE KERITE INSULATED WIRE & CABLE COMPANY, of New York, N. Y., has been incorporated with a capital stock of $500,000 by Richard Brixey, of Seymour, Conn.; Reginald W. Brixey, of New York, and Abel Crook, of Brooklyn. The company proposes to manufacture insulated wires, cables, etc.

THE ANTIQUE LAMP MANUFACTURING COMPANY, of New York, N. Y., has been incorporated, with a capital stock of $10,000, to manufacture lamps, lanterns, gas and electric fixtures, etc. The incorporators are: Henry Weissenberger, Albert Eisenberg and Fincus Wachsteter, all of New York, N. Y.

THE ATLANTIC COAST ELECTRIC & PROTECTIVE COMPANY, of Seabright, N. J., has been incorporated, with a capital stock of $10,000, by P. Hall Packer, of Seabright, N. J.; Joseph Swanson and James Otterberg, of New York, N. Y. The company proposes to do a general burglar-alarm electric contracting business.

THE CURTIS MARINE TURBINE COMPANY OF THE UNITED STATES, of Quincy, Mass., has been incorporated, with a capital stock of $10,000. The officers of the company are: Francis T. Bowles, of Barnstable, Mass., president; Kennard Winsor, of Brookline, Mass., treasurer, and Henry Endicott, Jr., of Weston, Mass., clerk.

THE DOWNINGTON MOTOR COMPANY, of Downington, Pa., has been incorporated, with a capital stock of $5,400. The directors are: Edward Kerr, treasurer; Guyon Miller, H. B. McFarlan, William H. Carey, Samuel P. Picking, Frank P. Miller, Joseph A. Bicking, J. Gibson McIlvain and Theodore Hallman, all of Downington, Pa.

COOPER & POWELSON, of New York, N. Y., have been chartered, with a capital stock of $100,000, to carry on a business of mechanical, electrical and hydraulic engineers and to do a general contracting business. The incorporators are: W. V. N. Powelson, J. P. Allen, both of New York, N. Y., and John C. Crowe, Jr., of West Orange, N. J.

THE CUBAN ENGINEERING & CONTRACTING COMPANY, of Jersey City, N. J., has been incorporated with a capital stock of $250,000, to do a general engineering and contracting business. The incorporators are: W. M. Clark, of Plainfield, N. J.; G. W. Hinckley, N. G. Bogue, E. Reiser, of Brooklyn, N. Y., and A. L. Richardson, of New York, N. Y.

THE MILLER HEATER, GAS & SMOKE CONSUMER MANUFACTURING COMPANY, of Orange, N. J., has been incorporated to manufacture the Miller water heater and the Miller gas and smoke consumer. The company is capitalized at $100,000, and the incorporators are: John Miller, Michael Winter, William F. Wurster, Robert Wright and James R. Stewart, of Orange, N. J.

Company Elections.

NEW BEDFORD, MASS.—At the annual meeting of the New Bedford Gas & Edison Light Company the following officers were elected: George R. Stetson president and manager; Charles R. Price, treasurer and clerk.

TURNERS FALLS, MASS.—At the annual meeting of the Franklin Electric Light Company the following officers were elected: J. F. Bartlett, president; E. I. Cassidy, secretary, and W. C. D. Thomas, treasurer.

PATERSON, N. J.—The directors of the North Jersey Rapid Transit Company have elected the following named officers: William A. Barbour, president; Malcolm R. McAdoo, vice-president, and H. H. Parmalee, secretary and treasurer. The company was formed with a capital stock of $2,000,000 to build an electric railway from Suffern, N. Y., to Paterson, N. J., work on which will begin at once.

ZANESVILLE, OHIO.—At the annual meeting of the Zanesville & Meigs Valley Traction Company the following named officers were elected: E. R. Meyer, president; C. T. Gale, vice-president; Fred M. Cruise, secretary, and A. J. Longstreth, treasurer.

New Incorporations.

EL MONTE, CAL.—The El Monte Home Telephone Company has been incorporated with a capital stock of $25,000 by J. S. Killian, F. P. Sappington, E. O. Fawcett, I. Kauffman and A. P. Snell.

OAKLAND, CAL.—Articles of incorporation have been filed for the Kaweah-Southern Power Company with a capital stock of $2,500,000, and the following directors: R. W. Kittrelle and W. Gabriel, of Berkeley; F. C. Watson, A. H. Dale, of Oakland, and Russell McHenry, of Piedmont.

DOVER, DEL.—The New Jersey & Delaware Power Company has been chartered with a capital stock of $1,000,000 by F. W. Mills, H. M. Browne, and E. J. Forhan, of New York, N. Y.

INDIANAPOLIS, IND.—The Indiana Lighting Company has filed articles of incorporation with the Secretary of State, with a capital stock of $4,500,000. The company is the outgrowth of the old natural gas interests, and the purpose is to build, establish and equip stations to supply light, heat and power to Ft. Wayne, Bluffton, Montpelier, Anderson, Lafayette, Logansport, Peru, Wabash, Decatur, Geneva, Berne, Crawfordsville, Lebanon, Thorntown and Frankfort, in Indiana, and also a number of towns in Ohio. The Rumler law, under which the corporation is organized, provides that light, heat and power may be supplied by means of artificial and natural gas, electricity, steam or hot water and transmitted and distributed. The principal office will be in Lafayette and Samuel T. Murdock will be general manager. The directors are: Samuel T. Murdock, Lafayette; H. C. Paul, Ft. Wayne; F. L. Babcock, A. M. Brady, C. F. Dieterich and F. S. Hastings, of New York, N. Y.

LEESBURG, IND.—The Public Service Telephone Company has been incorporated with a capital stock of $20,000 and the following directors: A. H. Brown, H. E. Kinsey, Frank Bortz, J. E. Armstrong and W. H. Stanley.

PALMYRA, IND.—Articles of incorporation have been filed for the Palmyra Home Telephone Company. The company is capitalized at $5,000 and the incorporators are: George A. Beach, L. A. Kahl, Floyd Thompson, H. T. Brown and Edward Wenning.

ARLINGTON, KAN.—The Arlington Central Telephone Company has been incorporated with a capital stock of $5,000 by A. C. Polk and E. Mayes, of Prague, Mich.; C. C. Pharris and others.

PORTLAND, MAINE.—The Peaks Island Water & Light Company has been incorporated with a capital stock of $20,000. The officers of the company are: E. E. Rounds, president; W. S. Crandall, clerk, both of Portland.

LESLIE, MICH.—The Leslie Home Telephone Company has been chartered with a capital stock of $30,000 to install and operate a telephone system in Leslie.

CYRUS, MINN.—Articles of incorporation have been filed for the Cyrus Mutual Telephone Company by H. C. Estly, O. E. Bjirgaad, L. L. House, John J. Kara and C. P. Carison.

KRAGNES, MINN.—The Oakport & Kragnes Telephone Company has filed articles of incorporation with the Secretary of State.

KEARNEY, NEB.—The Kearney Water & Electric Power Company has been organized with a capital stock of $310,000 to purchase the Kearney canal and electric power plant. It is said that extensive extensions will be made to the plant. William J. Scott is secretary of the company.

ROCHESTER, N. Y.—Articles of incorporation have been filed for the Rochester & Manitou Beach Railroad Company with a capital stock of $60,000. The company is successor to the old Rochester, Charlotte & Manitou Beach Railroad Company, of which W. Butler Crittenden was receiver, and which was bought at auction July 21 by Kendall B. Castle. The directors of the company are: Jacob Gerling, Charles S. Briggs, S. J. Scudder, Kendall B. Castle, Fred W. Odenbach, Henry W. Webel, of Rocherster; Allen J. Hallowell, of Buffalo, and Frank Gellie, of St. Johnsville.

BETHANIA, N. C.—The Rural Telephone Company has filed articles of incorporation with a capital stock of $24,000. The incorporators are: W. B. Little, H. A. Peddycord, George H. Hauser and others.

MARION, OHIO.—Articles of incorporation have been filed for the Marion & Galion Railway Company with a capital stock of $10,000, by F. H. Murphy and others. The object of the company is to provide a shorter route between Cleveland and Columbus.

PORTLAND, ORE.—The Gordon Falls & Manufacturing Company has been incorporated with a capital stock of $225,000 by Charles Cooper, George L. Peaslee and E. Y. Judd.

BOYERTOWN, PA.—Articles of incorporation have been filed for the Boyertown Electric Company with a capital stock of $5,000. The directors are: Levi E. Lefeaver, treasurer, Lewis P. G. Negley, George W. Unger, Charles B. Dotterer and Charles B. Spatz, all of Boyertown, Pa.

CENTER ROAD STATION, PA.—The Summit Independent Telephone Company is being organized to install a telephone system connecting Center Road Station with Penn Line, Steamsburg and other places. Cornelius Brooks, John W. Gaugh, Cory E. Curtis, Merrick Warren and others are interested in the enterprise.

LINCOLN, PA.—The Lincoln Electric Company has been incorporated with a capital stock of $5,000 and the following directors: Jacob Van-Wagner, treasurer; John F. Cockburn and J. H. Simpson, all of Pittsburg, Pa.

NISBET, PA.—The Nisbet Rural Telephone Company has been organized and a charter applied for. The company has commenced work on the construction of a telephone line which will eventually extend to Bastrap and other towns.

Obituary.

MR. CHARLES A. STEARNS, of Watertown, Mass., died Aug. 12 at Weld, Maine, where he was spending his vacation with his wife and daughter. Mr. Stearns was a well known electrical engineer, and for years was an electrical contractor, having retired from business several years ago. He was 70 years of age.

DR. W. M. HABIRSHAW.—It is with deep regret that we announce the death of Dr. W. M. Habirshaw from apoplexy at his summer home, Saratoga, N. Y., after a long illness. He had been in poor health for several years past and had needed the constant attendance of a trained nurse as well as the close watchfulness of his physician. Dr. Habirshaw, who was 74 years of age, was born in New York City and educated here. He served the U. S. Navy as an engineer during the Civil War and afterward resided for a time in England. He made chemistry his profession at an early period and did expert work for the New York Produce Exchange, the New York State Agricultural Society and other bodies. He was also at one time retained as chemist to the Peruvian government. He made special study of the qualities of rubber and gutta percha, and when the modern period of electrical development began took up the subject of insulation. As the result of this work the India Rubber & Gutta Percha Insulating Company was formed and soon took a prominent place in the art, becoming a few years ago the Habirshaw Wire Company. At the large works at Yonkers, on the banks of the Hudson, Dr. Habirshaw produced a number of specialties, and the wires and cables there made are in use throughout the world. He was consulted frequently by the leaders in the art and enjoyed the close friendship and intimacy of such men as Samuel Insull, Nikola Tesla, Edward Weston, William Stanley, C. R. Huntley, L. B. Stillwell and Arthur Williams. He was, moreover, a man of wide culture and liberal tastes and knew every New Yorker of any prominence. He made his home for years at Delmonico's, and his dinner table there was a rendezvous for scientists, authors, actors, dramatists, artists, opera singers, army and navy men, financiers and others, extending hospitality to them of the most generous and wholesouled character. He was also an active member of the Union League, Century, Chemists, Electrical, New York Yacht and other clubs, and until lately took a keen delight in club life. He was a member of the Chemical Society of London and of other technical and engineering organizations. He will be sorely missed by a host of friends, whom he ever drew closer to himself by acts of kindness and gentle courtesy; and his loss will be deeply felt in the fields of chemistry and electrical engineering. The funeral services took place at St. Thomas' Church, Fifth Avenue, New York, on Aug. 19. On Aug. 17 the board of trustees of the Habirshaw Wire Company adopted a series of resolutions recognizing his worth and ability, and emphasizing his skill as an analytical chemist. The works were closed on the day of the funeral as a mark of respect, and the service at the church was largely attended by members of the executive staff and of the force.

DR. W. M. HABIRSHAW.

Personal.

MR. A. L. GILLETTE, formerly of Chippewa Falls, Wis., has been appointed general superintendent of the Centralia Gas & Electric Company, Centralia, Ia.

MR. JOSEPH J. DAWES, who was formerly with the Union Gas & Electric Company, of Cincinnati, has been made power expert and engineer for the Rockford (Ill.) Electric Company, a very enterprising and progressive organization.

MR. H. C. HIGGINS, formerly of Dixon, Ill., has purchased the plant of the Centralia (Ia.), Gas & Electric Company. Mr. Higgins also owns the Gadsden, Ala., gas plant, and is interested in the Manitowoc & Two Rivers, Wis., railway system.

MR. FRANK W. GRAHAM, formerly superintendent of construction of the Jamestown Exposition, has become associated as assistant manager of electrical construction with the Chicago-Milwaukee Road & Realty Company, a concern organized to build a combination electric, automobile and carriage road from Chicago to Milwaukee, with offices at 134 Monroe Street, Chicago.

MR. THOMAS G. GRIER is the author of a book just published by Wagner & Hanson, of Chicago, entitled "On the Canal Zone." The book is the result of a recent visit by Mr. Grier to the Isthmus, and gives his observation upon the nature and progress of work on the canal, upon the country and the people, illustrated profusely with reproductions of photographs. Incidentally the few matters of electrical interest observed are noted, but otherwise the book does not reveal the profession of the author.

MR. W. H. MACGREGOR.—Mr. W. H. MacGregor, who for the past eight years has been with the Westinghouse Electric & Manufacturing Company in New York, has resigned his position as senior salesman in the detail and supply department to assume the position of manager of the New York sales office of the Dictaphone Company of America. The dictaphone is an electrically driven dictating machine. Mr. MacGregor's many friends in the electrical business unite in wishing him success in his new line of work.

COOPER & POWELSON have opened offices as consulting engineers and managers at 60 Wall Street, New York City, the firm being a corporation formed under the laws of New York. Mr. Hugh G. Cooper will discontinue business under his own name, and Mr. W. V. R. Powelson will discontinue his connection as president, general manager and treasurer of the Union Electric Light & Power Company, of St. Louis. Both will devote their entire time to the new corporation, which is engaged in examining, organizing, designing, operating and managing hydraulic, steam and electric power plants, electric transmission lines and distributing systems. It is understood that the firm now has in hand some very important work on hydro-electric enterprises on the Mississippi River.

MR. H. T. MATTHEW.—We are glad to announce that Mr. H. T. Matthew will hereafter represent the ELECTRICAL WORLD as Western business manager, with headquarters in Chicago, succeeding the late Mr. J. V. S. Church, whose sudden death was noted in these columns recently. Mr. Matthew, who has already been identified with the interests of the McGraw Publishing Company for some years, is a native of St. John, New Brunswick, and was born there 30 years ago. His father, Dr. G. F. Matthew, is in the government fiscal service and enjoys an international reputation as a distinguished paleontologist. Mr. H. T. Matthew came to the United States to push his fortunes and entered the McGraw ranks in 1901. He became associated with the advertising department of the *Street Railway Journal* in 1902, and a year later was appointed business manager of *Electrochemical Industry*, a position which he has held with success up to the present time, making a wide acquaintance and winning many friends in the electrical field. Mr. Matthew has been a member of the American Electrochemical Society since 1906 and has taken an active, public-spirited interest in its affairs. In selecting him for his new post the management of ELECTRICAL WORLD believes that Mr. Matthew will be thoroughly acceptable and will maintain with its advertisers and readers in the West the intimate cordial relationships established by his predecessor. Mr. Matthew enters at once upon his new duties.

H. T. MATTHEW.

Legal.

AJAX.—In the item published Aug. 1 in this column respecting the trademark controversy between the George Cutter Company and the Ajax Line Material Company, by inadvertence a portion only of the decision of the Examiner of Interferences was given. The decision was as follows: "An abandonment by the George Cutter Company of the trademark at issue in this interference having been filed, and the same having been found to comply with the requirements of Rule 125, it is adjudged that the Ajax Line Material Company, the junior party, is the owner of the trademark and entitled to the registration for which it has made application."

Trade Publications.

DIRECT READING OHMMETER.—The Keystone Electrical Instrument Company, Ninth Street and Montgomery Avenue, Philadelphia, has just issued a pamphlet illustrating and describing its new direct reading ohmmeter to which attention was called recently in these pages. The illustration given shows a type of outfit designed specially for the measurement of carbons or other low resistance objects of considerable area and of variable length and size. The pamphlet is Bulletin No. 14-B and can be obtained on application, with further data.

CONTROLLERS FOR POWER AND MINING.—Bulletin No. 4600, issued by the General Electric Company, Schenectady, N. Y., describes various types of controllers for use in connection with both alternating and direct current motors, on electric cars, locomotives, automobiles, launches, elevators, trains, hoists, etc., and also in rolling mills, machine shops, printing plants and pumping stations. The bulletin describes the controller most suitable for each specific purpose, and contains general data and dimensions.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., are now distributing a new handbook, giving considerable data on lighting with tungsten lamps. Tables are given, showing the cost of lighting with tungsten lamps, as compared to gas mantles and gas arcs, this being worked out at various values from 2 to 13 cents per kw-hour. This book embodies some 24 pages and should prove of interest to central stations in demonstrating to their customers the efficiency of tungsten lamps as compared to gas mantles.

THE SUCTION GAS PRODUCER.—The Weber Gas Engine Company, Kansas City, has issued a pamphlet setting forth the economy in producing power from a gas-producer, gas-engine combination. The modern gas power plant uses less than one-half the coal required by a steam power equipment. It is shown that the suction gas producer converts from 75 to 80 per cent of the heat values in the fuel into available, clean gas, and furthermore, can utilize many low grade fuels such as lignite and peat. The pamphlet also fully describes the Weber "Down-draft" suction gas producer, and gives remarkable results covering tests on a large number of diversified kinds of bituminous fuel.

SERIES INCANDESCENT TUNGSTEN LAMPS.—There is a tendency toward the illumination of the streets of residential districts by means of the series incandescent system of lighting. The principal objection to this system, namely, the low efficiency of the appropriate lamps, has been eliminated by the introduction of the series tungsten lamp which has an efficiency of 1½ watts per cp. A series system utilizing tungsten lamps is fully described in Bulletin No. 4607, just issued by the General Electric Company, Schenectady, N. Y. This description includes illustrations and general data on transformers, switchboards, lamp brackets and reflectors, series sockets and lightning arresters, used in connection with the system.

Business Notes.

DOSSERT & COMPANY, 242 West Forty-first Street, New York, report the receipt of large orders for their solderless connectors from the Philadelphia Electric Company, Philadelphia, Pa.; the Birmingham Coal & Iron Company, Mulga, Ala., and the San Francisco Gas & Electric Company, San Francisco, Cal.

BIRD-ARCHER COMPANY.—After Sept. 1 the main offices of the Bird-Archer Company will occupy the 22d floor of the West Street Building, New York City. The new offices contain more than four times the floor space of the present seven-room offices. This quadrupling of floor space, made necessary by an unexpectedly large increase in business during the short time in which the company has occupied the present offices, speaks well for Bird-Archer products and enterprise. The demand for boiler compounds in the Orient especially seems to be very promising, as the Bird-Archer Company now sends out its Asian shipments in five-car lots. These are usually consigned to Pacific Coast agents, who reship to the foreign agents and customers. Mr. P. B. Bird, president of the company, expresses the opinion that American industry must be active in Cuba, as the demand for boiler compounds on the island has grown beyond all prophesies.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED AUG. 11, 1908.

[Conducted by Rosenbaum & Stockbridge, Pat. Attys., 41 Park Row, N. Y.]

895,423. BOX CONNECTION; William S. Brown, New York City, N. Y. App. filed March 27, 1907. An outlet box plug or connection formed of spun sheet metal and adapted to clamp upon a cable and within the box by the single act of its insertion.

895,431. INCLOSED FUSE; Robert C. Cole, Hartford, Conn. App. filed Jan. 31, 1907. Employs the usual cylindrical casing of a cartridge fuse and a reticulated screen formed of fuzzy material to retain the sand within the fuse box while permitting the escape of gases through the vent holes.

895,432. INCLOSED FUSE TERMINAL; Robert C. Cole, Hartford, Conn. App. filed Feb. 16, 1907. Relates to modifications of the above.

895,434. VEHICLE SPEED SIGNAL; George L. Cooper, Troy, N. Y. App. filed Feb. 20, 1908. The car is provided with a visual signal and means for exhibiting said signal, said means being operative only when the car is in motion without applied power.

895,441. ELECTRIC OUTLET BOX; Conrad J. Dorff, Chicago, Ill. App. filed June 22, 1907. Relates to the process or manufacture of an outlet box having portions which are punched entirely out and reinserted, the punched out portions having lugs which interlock to subsequently retain them in the holes from which they were punched.

895,460. THERMOSTATIC CIRCUIT CONTROLLER; Herman L. Hicks, Martins Ferry, Ohio. App. filed Feb. 15, 1908. Makes use of a non-fusible base to which an expansible bridge is secured, the bridge being fastened at its ends and in electrical connection with a pair of resilient fingers by means of which the device is held in place.

895,485. VACUUM TUBE LIGHTING; Daniel McFarlan Moore, Newark, N. J. App. filed April 2, 1906. Relates to an arrangement of tubes for vacuum lighting system of the ordinary Moore type. Provides means whereby the lighting may be controlled in the different tubes independently from one another.

895,486. VACUUM TUBE APPARATUS; Daniel McFarlan Moore, Newark, N. J. App. filed April 2, 1906. Relates to modifications of the above.

895,487. VACUUM TUBE APPARATUS; Daniel McFarlan Moore, Newark, N. J. App. filed April 2, 1906. Has the usual vacuum tube and a closed receptacle containing a vaporizable material and a magnet operated valve interposed in the passage between said receptacle and the tube, whereby the density of the gases in the tube is properly maintained.

895,490. SYSTEM FOR THE GENERATION AND DISTRIBUTION OF ELECTRICITY; Thomas H. McAdory, Chicago, Ill. App. filed April 17, 1908. Makes use of a generator and storage battery where the dynamo is driven at variable speeds. Provides an automatic switch to prevent overcharging of the battery.

895,506. ELECTRIC BELT; Victor Sence, of New York, N. Y. App. filed June 6, 1907. Therapeutic appliance making use of a belt having dry batteries and electrodes together with current interruption means to produce a pulsating current flow.

895,515. DYNAMO ELECTRIC MACHINE; Egbert M. Tingley, Pittsburg, Pa. App. filed April 4, 1906. A stationary armature for dynamo electric machines comprising a frame, a laminated core, coils surrounding said core, non-magnetizable coil supporting members, and means for connecting said members to the frame independently of the core.

895,519. FURNACE FOR EFFECTING FUSION FOR REFINING; Emilien Alphonse Omer Viel, Paris, France. App. filed Nov. 19, 1907. Has a crucible entirely inclosed except for a small perforation and an arc is blown into the crucible through the perforation by a magnet.

895,531. SILOXICON COATED CARBON CONTAINING ARTICLE; Edward Goodrich Acheson, Niagara Falls, N. Y. App. filed July 2, 1906. A shaped graphite electrode having a coating of siloxicon.

895,545. CONNECTING DEVICE FOR ELECTRICAL CONDUCTORS; Ernest Benjamin Fahnstock, of New York, N. Y. App. filed Nov. 24, 1905. A terminal clip comprising a hook received through an opening in the spring blade and adapted to embrace the conductor from which a connection is to be made.

895,549. STORAGE BATTERY; George A. Ford, Cleveland, Ohio. App. filed Oct. 27, 1905. A storage battery of the type having superposed trays which nest together. The trays are made of molded paper pulp having a reinforced, upturned, marginal flange.

895,575. ELECTRIC CAR RECORDING BLOCK SIGNAL; William J. Murray, Leavensworth, Kan. App. filed April 16, 1907. Car recording block signal system for use with single track trolley roads. Designed to indicate the entrance of a car into a block to cars approaching from the opposite end. Allows subsequent cars to enter behind an advancing car unless the first has passed out of the block.

895,582. RAIL BOND FOR ELECTRIC RAILWAYS; William E. Oakley, Millbury, Mass. App. filed Dec. 2, 1904. A rail bond having cylindrical protuberances received through the rail web and hollowed out so that they may be turned over at their edge and riveted to the rail web.

895,589. ELECTRIC SIGNAL FOR RAILWAYS; John Sherman Sims, Longbeach, Cal. App. filed Sept. 25, 1907. Has sectionally electrified track rails energized by direct current and including specially constructed relays in their circuits, designed to control lamps and semaphore signals.

895,594. ARC LAMP; Bernard A. Stowe, Cleveland, Ohio. App. filed Aug. 3, 1905. Has means embodied in an arc lamp adapted to control the rate of consumption of the carbons consequent upon the fluctuations of the arc and the pumping action of the moving carbons.

895,618. POWER TRANSMITTING DEVICE; Leonard K. Clark, New York, N. Y. App. filed Nov. 20, 1906. The generator is provided with a rotary armature member and a rotary field member and a motor having a rotary armature member and a fixed field member. Has means for coupling together and uncoupling the generator armature member and the motor armature member.

895,638. WATER HEATING SYSTEM; Harry M. Hill, St. Louis, Mo. App. filed May 13, 1907. A water heater making use of a chamber in the pipe connection through which the water circulates and having a pair of tubular electrodes. The current is controlled by a plunger operated switch displaced by the flow of the water.

895,645. VALVE TIMING DEVICE FOR EXPLOSIVE ENGINES; Lester L. Kell, St. Louis, Mo. App. filed Dec. 17, 1907. In place of a spark plug, patentee has a plunger device in the path of the piston, the purpose of which is to provide an accurate testing indication when the engine is at a dead center.

895,660. ELECTRIC BATTERY; William Morrison, Chicago, Ill. App. filed Aug. 11, 1902. A bromin storage battery having a cell constituting the negative element, the battery being so constructed that the deposit of bromin is held by gravity upon the upper surface of the bottom of the cell, said upper surface being the negative element.

895,695. SUPPORT FOR TELEPHONE RECEIVERS; Frank Simons, Buffalo, N. Y. App. filed Oct. 1, 1906. A wire frame for holding a receiver in proper relation to a transmitter while talking.

895,714. BINDING POST; Garrison Babcock and Josef Reuter, Rochester, N. Y. App. filed June 25, 1906. A binding post having a pair of plates with beveled edges which are impelled together to claim a wire by binding screws.

895,715. THERMOCHEMICAL GENERATION OF ELECTRICITY; Lucien Paul Basset, Paris, France. App. filed March 27, 1906. A thermochemical process of generating electricity in which a calorific energy which becomes free is transformed into electrical energy. A type of bromin battery.

895,732. CONSTRUCTION OF BATTERIES AND ELECTROLYTIC APPARATUS; Frank A. Decker, Philadelphia, Pa. App. filed Feb. 11, 1905. Makes use of a plurality of rubber trays which are secured together and sealed by soft rubber vulcanized in a seam of the abutting edges.

895,747. BINDING POST; Monroe Guett, Hartford, Conn. App. filed Oct. 5, 1906. Has a cylindrical casing in which a pair of plungers are impelled by a screw to make connection with the wire.

895,752. LIGHTNING ARRESTER; Ernst Heddaeus and Rudolf Nothnagel, Bilbao, Spain. App. filed Nov. 30, 1907. In place of a fixed spark gap in a lightning arrester, patentee has wheels which are rotated positively so as to prevent a varying spark gap dependent upon the contour of their peripheries.

895,760. SYSTEM FOR ELECTRICAL DISTRIBUTION; Robert C. Hull, Philadelphia, Pa. App. filed Jan. 3, 1908. Comprises a storage battery and regulating means for causing the battery to charge and discharge and other slow-acting automatic means for counteracting the first. Is used for regulating the fluctuations of an intermittent load in which the average load varies over a considerable range within comparative short intervals of time.

895,772. SECONDARY ELECTRIC CLOCK; Frank F. Landis, Waynesboro, Pa. App. filed Sept. 11, 1906. Construction of a mechanism of a secondary clock designed to eliminate all spring, and in which the train is prevented from rising while the holdback pawl is disengaged.

895,785. MEANS FOR SUPPLYING AND CONTROLLING ELECTRIC CURRENT TO MOTOR VEHICLES; Alexander Palmros, Columbus, Ohio. App. filed Sept. 12, 1900. A controller for mine locomotives. Has a slider moving over contacts and impelled by a solenoid.

895,801. CURRENT TRANSFORMER; Paul Schubert, Berlin, Germany. App. filed Aug. 27, 1906. A current transformer having a core, a secondary winding and a primary winding and means connected in the primary winding for producing two opposing alternating fluxes in the core.

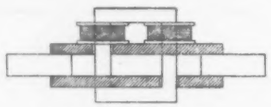
895,806. TROLLEY; Frank L. Sessions, Columbus, Ohio. App. filed May 24, 1904. A current collecting device for electric locomotives. Makes use of a long cylindrical roller impelled by a bail-shaped harp in place of the usual grooved roller.

895,811. CONTACT DEVICE; Samuel B. Stewart, Jr., of Schenectady, N. Y. App. filed March 1, 1904. Covers a construction of current collector for electric locomotives having a rod displaced vertically by a parallel link motion and supporting a cylindrical roller.

895,822. RHEOSTAT; Charles Wirt, Philadelphia, Pa. App. filed July 12, 1905. A rheostat having a spirally wound resistance and a commutator within a molded body and connections between the commutator and resistance outside the body.

895,823. SYSTEM FOR ELECTRICAL DISTRIBUTION; Joseph L. Woodbridge, Philadelphia, Pa. App. filed Oct. 2, 1907. In combination a synchronous dynamo electric machine and mechanically connected thereto an induction machine provided with rotor and stator windings, whereof one is adapted for connection to a polyphase circuit; means for connecting appropriate points of the other of said windings to the synchronous machine, and an independent circuit connecting other points in said winding.

895,824. ELECTRIC GENERATOR; Joseph L. Woodbridge, Philadelphia, Pa. App. filed Dec. 7, 1907. A field frame for a dynamo electric machine provided with poles of which more are of one polarity than of the opposite polarity, means for producing a mag-



895,801—Current Transformer.

netic flux unequally distributed between the first-mentioned poles and an armature with its commutator and brushes adapted to develop unequal electromotive forces between the brushes when the armature is revolved in the unequal distributed flux.

895,825. SYSTEM FOR ELECTRICAL DISTRIBUTION; Joseph L. Woodbridge, Philadelphia, Pa. App. filed Jan. 3, 1908. Relates to modifications of No. 895,823.

895,830. ELECTRIC BRAKE; Edward H. Anderson, Schenectady, N. Y. App. filed July 25, 1901. Patentee has a form of motor directly connected to the usual brake spindle and adapted to operate conjointly with the actuation of the usual handle.

895,831. CONSTANT CURRENT TRANSFORMER; Lyman Arnold, Lynn, Mass. App. filed March 9, 1907. A transformer of the type having a plurality of movable coils displaced by counterweights. Has a common magnetizable core for all the sets of coils with a magnetic member separating the sets.

895,836. CONTROLLING DEVICE FOR ELECTRIC MOTORS; Ralph E. Barker, Lynn, Mass. App. filed Dec. 26, 1907. A starting device for electric motors comprising a switch for closing the motor circuit, a contacting surface movable toward and from a horizontal position by the operation of said switch, and an element movable by gravity over said surface to affect the circuit.

895,854. VOLTAGE PROTECTOR; George T. Hanchett, Hackensack, and Henry M. Shaw, East Orange, N. J. App. filed Oct. 3, 1906. The combination of two terminals presenting opposing faces to one another, one of said terminals having a passage therethrough, and means for forcing a non-conducting liquid toward the other terminal and through said passage.

895,857. RESISTANCE UNIT; Joseph L. R. Hayden, of Schenectady, N. Y. App. filed March 29, 1907. Makes use of a solid stick of cast silicon having an iron terminal which is welded to the stick so as to form ferro-silicon.

895,864. TROLLEY; Albert S. Janin, New York, N. Y. App. filed Dec. 12, 1906. A parallel motion for the current collectors of electric locomotives designed to provide a fender for the gearing and joints of the frame.

895,869. RECTIFIER SYSTEM; Osias O. Kruh, Schenectady, N. Y. App. filed Dec. 28, 1906. Has a single-phase, alternating-current source and a plurality of transformers connected thereto and having secondaries supplying energy to a vapor electric device and means for displacing the phase of current in one transformer primary.

895,878. BRUSH HOLDER; Floyd C. Mitchell, Schenectady, N. Y. App. filed April 20, 1906. Provides a form of brush holder having a projecting spring blade which is impelled by a set screw to tension the brushes.

895,887. ACYCLIC MACHINE; Jakob E. Noeggerath, Schenectady, N. Y. App. filed Jan. 16, 1906. In a dynamo-electric machine, a revolving armature, a stationary homopolar field structure, having poles uniformly around the armature, a magnetizing winding surrounding and carried by the armature, a non-magnetic shell surrounding said winding and restraining it against centrifugal force, and collector rings carried by said shell.

895,888. UNIPOLAR DYNAMO-ELECTRIC MACHINE; Jakob E. Noeggerath, Schenectady, N. Y. App. filed April 1, 1907. In a dynamo-electric machine, a unipolar field structure, an armature provided with a plurality of collector rings, a detachable member secured to the field structure, and conductors for cross-connecting the collector rings carried by and movable with said member.

895,894. MEANS FOR COOLING DYNAMO-ELECTRIC MACHINES; Richard H. Rice, Lynn, Mass. App. filed Nov. 2, 1907. Relates to cooling of turbo-generators of the vertical type. Has an annular chamber around the generator and opening through which air is designed to circulate according to a definite scheme of circulation flow depending upon the varying density of the warm and cool air in the respective pipes and chambers.

895,911. WALL BRACKET FOR ELECTRICAL CONDUCTORS; Lucius Tinsley, Crawfordsville, Ind. App. filed Dec. 7, 1907. A wall bracket comprising a plurality of insulating members and a clamping member having a base surrounding the sides of one of the insulating members and provided with a yoke extending over the top of the other insulating member.

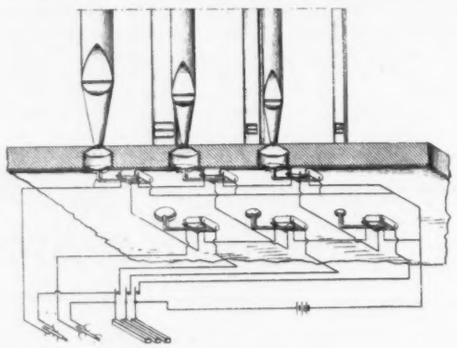
895,914. VARIABLE VOLTAGE TRANSFORMER; Matthew O. Troy, Schenectady, N. Y. App. filed Dec. 22, 1905. Has a core and coils spaced apart on said core and magnetically balancing the means adapted to shift the flux from one portion of said core to another.

895,916. LIGHTNING ROD TERMINAL; John P. Turner, New York, N. Y. App. filed Aug. 20, 1907. Makes use of a hollow pyramidal perforated casing containing pulverized charcoal and which is clamped upon the lightning conductor so as to inclose the same.

895,925. ELECTRIC ORGAN; William R. Whitehorne, Bethlehem, Pa. App. filed Sept. 7, 1906. The organ has magnetically displaced valves of special construction.

895,928. RAIL BOND; Montraville M. Wood, Chicago, Ill. App. filed Sept. 9, 1901. A railbond designed to be expanded into a hollowed out portion of the rail web by the use of a tapered pin.

895,930. PROCESS OF ELECTROLYTICALLY PRODUCING CHROMIC ACID FROM CHROMIC SULFATE; Gustav Adolph, Ammen-



895,925—Electric Organ.

dorf, and Albert Pietzsch, Madgeburg, Germany. App. filed April 27, 1907. Designed to carry out the process with an acid solution of the electrolyte and in the absence of a diaphragm between the electrodes.

895,933. SELF-EXCITING GENERATOR; Ernest F. W. Alexanderson and Emil H. Widegren, Schenectady, N. Y. App. filed Nov. 21, 1907. In an alternating-current generator, a field winding provided with a rectifying commutator and a polyphase arrangement of brushes bearing thereon, means for supplying polyphase shunt voltages to said brushes to excite the field, means for compounding said voltages for variation of load on the generator, and means for adjusting the exciting circuits to compensate for unequal compounding of the different phases of said exciting voltages.

895,956. LIGHTNING ARRESTER RESISTANCE; Harold W. Buck, New York, N. Y. App. filed Jan. 25, 1907. Makes use of a tubular braided fabric inclosing powdered carborundum or lamp black.

895,965. REGULATION OF DYNAMO-ELECTRIC MACHINES; Reginald C. Clinker, Rugby, England. App. filed Sept. 28, 1905. A means for reducing sluggishness and causing the flux of a generator to respond more quickly to a change of current than is accomplished by present systems, including boosters and regulators. Has a transformer with two windings, one connected in series with the machine and the other in shunt to the field winding thereof.

895,977. COMBINED FUSE BOX AND CUT-OUT SWITCH; Christopher C. Dawber, Clifton, Ariz. Ter. App. filed June 26, 1907. Protective device for light, power, telegraph and telephone circuits, making use of contracts between ordinary fuse wires which may be received and which are separated by a diaphragm.

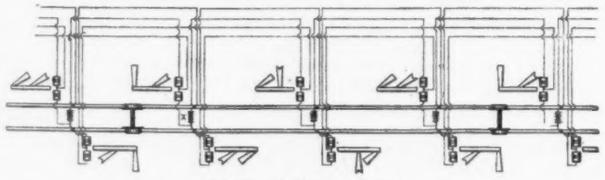
895,978. APPARATUS FOR TRANSMITTING AND REPRODUCING SOUNDS; Joseph Arthur Lovel Dearlove, London, England. App. filed Jan. 30, 1905. Has means by which the water pressure on one side of a diphragm of a submarine transmission is balanced by an equivalent air pressure on the other side.

895,983. RAILWAY SIGNAL; Hoyt A. Dillon, Council Bluffs, Ia. App. filed Aug. 19, 1907. Details of a semaphore actuating apparatus making use of an arm which drops by an electromagnetic trip and which is raised by an electric motor or by an operating cord or chain.

895,993. TROLLEY SUPPORT; Hiram G. Farr, Melrose Highlands, Mass. App. filed Oct. 22, 1907. The trolley wheel is made hollow and filled with absorbent material containing lubricant. The spindle is also hollow and contains a similar supply of lubricant.

896,005. ATTACHING PLUG; Henry Geisenhoner, Schenectady, N. Y. App. filed Aug. 22, 1903. An attachment plug of the type which can be received in an ordinary threaded socket, and having an additional pull-out for convenient rupture of the circuit without removing the threaded plug from the lamp socket.

896,060. FILAMENT FOR ELECTRIC INCANDESCENT LAMPS AND PROCESS OF MAKING THE SAME; Hans Kuzel, Baden, near



895,983—Railway Signal.

Vienna, Austria-Hungary. App. filed May 7, 1907. As a new article of manufacture, a thread capable of being converted into crystalline tungsten filament and containing tungsten and colloidal oxyndrid of tungsten.

896,071. ELECTRIC RAILWAY; John A. Garey, Mound City, Mo. App. filed Aug. 12, 1907. A form of plow and conduit structure by which the third rail is received in a spring-closed conduit, the conduit being opened by the passage of the plow and automatically closed therebehind.

12,841. ELECTRIC SWITCH; Everett M. Coffin, Oakland, Cal. App. filed June 24, 1908. Covers a double-throw snap switch of the wall type having a pair of detents which are displaced by a cam to release the switch element.